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ABSTRACT

A study investigated the relationships among language proficiency, learning mode, learning style, abstract reasoning, and age of second language acquisition in 227 adults. The subjects, most of whom were university students, included 17 monolinguals, 120 partial multilinguals, and 90 competent multilinguals. For comparison with competent multilinguals, the monolinguals and partial multilinguals were grouped together. All were tested for language proficiency, learning style (diverger, assimilator, converger, accommodator), learning mode (concrete experience, reflective observation, abstract conceptualization, active experimentation), and analogy-solving ability. Native English-speakers had higher analogy-solving scores than native speakers of other languages, regardless of language proficiency; competent multilinguals scored highest. Among competent multilinguals, native English-speakers scored higher than non-native speakers. Competent multilinguals scored lower on reflective observation than did other subjects. There was also a significant negative correlation between learning mode and analogy-solving ability. No significant difference was found in learning styles, and no significant interaction effect between language proficiency and learning mode or style on analogy-solving ability. Individuals learning the second language after age 12 had higher analogy-solving scores than those learning it earlier. However, early-second-language-learners were more likely to be competent multilinguals. (Author/MSE)

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ED 363 091

A STUDY OF THE RELATIONSHIPS AMONG MULTILINGUALISM, LEARNING STYLE, AND COGNITION

BY

ELEANOR AVINOR

B.A., University of Haifa, 1970

M.A., University of Haifa, 1981

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DISSERTATION

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Doctor of Philosophy in Education

The University of New Mexico
Albuquerque, New Mexico

May, 1993

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A STUDY OF THE RELATIONSHIPS AMONG MULTILINGUALISM, LEARNING STYLE, AND COGNITION

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ABSTRACT OF DISSERTATION

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May, 1993

ABSTRACT

A STUDY OF THE RELATIONSHIPS AMONG MULTILINGUALISM, LEARNING STYLE, AND COGNITION

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The relationship among language proficiency, learning mode, learning style, and cognition was investigated. Language proficiency was determined by a language survey questionnaire. Multilinguals were also grouped according to the age at which they acquired the second language: early (before age 12) and late (after age 12). Learning mode and style were defined according to the Kolb Learning Style Inventory which measured the respondents' relative use of four learning modes: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Combining learning mode scores yielded learning styles of diverger, assimilator, converger, and accommodator. Abstract cognitive performance was measured in terms of the subjects' analogy-solving ability as demonstrated on the 100-item practice Miller Analogies Test (PMAT).

Among the 227 subjects, there were 17 monolinguals, 120 partial multilinguals, and 90 competent multilinguals. Because of the small

number of monolingual subjects, monolinguals and partial multilinguals were grouped together.

For the entire group of 227 respondents, knowledge of more than one language was not linked to improved analogy-solving performance. Subsidiary analyses of subgroups of the respondents, however, indicated that knowledge of more than one language is associated with improved analogy-solving ability. Native speakers of English had significantly higher PMAT scores than native speakers of other languages, regardless of language proficiency. Among native speakers of English, however, competent multilinguals scored significantly higher on the PMAT than monolinguals/partial multilinguals. Finally, among competent multilinguals, native speakers of English scored significantly higher on the PMAT than nonnative speakers of English.

Learning modes were found to be significantly different: RO (reflective observation) scores were significantly lower for competent multilinguals than for monolinguals/partial multilinguals. In addition, there was a significant negative correlation between learning mode RO and PMAT scores.

No significant difference was found for learning styles between monolinguals/partial multilinguals and competent multilinguals. There was no significant interaction effect of language proficiency and learning mode or style on analogy-solving ability.

The age at which a person acquires a second language was linked with the ability to solve analogies. Persons who acquired their second language late (after age 12) achieved higher PMAT scores than did those who acquired a second language before the age of 12. On the other hand, persons who acquired the second language early were more likely to be competent in both languages. The age at which a person acquired the second language, however, was not linked with learning mode or style.

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CHAPTER 1

MULTILINGUALISM, LEARNING STYLE, AND COGNITION

Introduction

This study investigated relationships among linguistic competence in more than one language, preferred learning mode, learning style, and cognition. Linguistic competence was measured through a self-report language survey questionnaire; learning style was determined by the Kolb Learning Style Inventory; and cognition was assessed by the solution of analogies as determined by a practice Miller Analogies Test (PMAT).

Multilingualism is not only an asset in communication and world trade, but also a necessity. The recent recognition of the diverse student population in the United States has awakened an interest in the relationships between and among multilingualism, learning style, and cognition.

If "knowing" more than one language, and thus, more than one culture, enhances cognitive flexibility and perhaps even has an impact on learning style, then school curricula should take this influence into consideration. Current researchers such as Saville-Troike (1976) use the term "salad bowl" instead of "melting pot" to reflect new research which supports a multilingual/multicultural picture of American society. The concept of salad bowl to reflect cultural pluralism may also be termed a "mosaic."

The American educational system, however, has paid little attention to bilingualism and its impact on abstract thinking skills. Some believe that bilingualism is connected with a situation disadvantageous to learning (Ferguson and Huebner, 1989). The lack of evidence and indifference to the importance of multilingualism in learning provided the impetus for conducting this study.

Statement of the Problem

It is possible that the monolingual, unhampered by more than one language code, can achieve higher test scores in a test examining analogy-solving abilities or abstract thinking skills. It is possible, on the other hand, that the multilingual person, by being freed of the constraints of one language and one language system, and by acquiring more than one referent for his words, possesses a metalinguistic awareness and strategy of code-switching which enable achievement of higher scores.

According to Cummins's (1981) model, language proficiency development may be conceptualized as two intersecting continua, one continuum describing language as being context embedded (experiential) or context reduced (learning out of context), and the intersecting continuum describing language skills as being cognitively demanding (demanding cognitive manipulations) or cognitively undemanding. Tasks that are context reduced may be cognitively demanding when they are performed for the first time, but the learner may become trained in performing these tasks and they become easier with training, practice and experience. This training and practice is one of the "spin-off effects" of being multilingual (Segalowitz, 1977).

In comparison with the monolingual, then, the multilingual may possess a greater variety of perspectives or frames of reference which may result in improved scores on tests that examine analogy-solving abilities or abstract thinking skills. The multilingual's performance may be affected by the availability of more numerous and varied words and ways of categorizing reality.

There are two phenomena which contribute to the importance of this study: (a) an increasing proportion of the population of the United states is heterogeneous and multilingual; and (b) a world "shrinking" to become a global village.

As more multilingual (and multicultural) learners are applying for admission to institutions of higher learning, the question of test fairness is becoming more important. Some tests may favor western modes of thought, discriminating against nonwesterners. Academic success depends on cognitive skills. It may be that admissions tests favor students from the tradition of western culture (i.e., native English-speaking, middle-class, western, humanistic-oriented learners). It may also be that certain learning styles are more conducive to academic success than others, and that tests cause admissions offices to refuse students whose thinking patterns are different from the norm.

The cognitive skill selected for this study was the solving of analogies. It was assumed that this skill, represented on most admissions tests, is an indicator of abstract cognitive abilities.

It is possible that cognitive style may interact with the number of languages a person knows, especially if they are not closely related, for example, English and Hebrew, Arabic, Japanese, or Chinese. Students speaking languages, and by extension participating in cultures, that are similar to English may not encounter test bias, whereas students speaking languages different from English may be at a disadvantage.

The question of different learning styles is also pertinent. People learn in different ways and have significantly different learning styles. Some learning styles may be more efficient than others for passing certain tests. Is it the teacher's job to teach everybody to use the same learning styles, or is there room in the educational system for variety without prejudice?

Kolb (1984) described experiential learning as real learning and real education. Experiential learning is "a holistic integrative perspective on learning that combines experience, perception, cognition, and behavior" (p. 21). It is learning from experience in the complex world and was so-named to emphasize the central role that experience plays in the learning process. This kind of learning takes place when learners develop and grow in all four learning modes. The modes wherein their propensities lie are their preferred modes and the ones they are most comfortable in and have the most successes in; hence, these learning styles are important for the learners' self-concept and feelings of achievement and success.

Purpose of the Exploratory Study

The purpose of this exploratory study was to determine if there are relationships between and among multilingualism, learning style, and ability to solve analogies.

The questions to be investigated by this research can be phrased as follows:

1. Is there a significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to ability to solve analogies?

2. Is there a significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to learning mode and/or learning style?

3. Is there a relationship between analogy-solving performance as evidenced in PMAT scores and the four learning modes and/or learning styles?

4. Is there any significant interaction between learning mode and/or learning style and language proficiency (monolingualism/partial multilingualism and competent multilingualism) with respect to the ability to solve analogies?

5. Is there a relationship between performance on the PMAT and the age at which a second language is learned (before or after age 12)?

6. Is there a relationship between learning modes and/or learning styles and the age at which a second language is learned (before or after age 12)?

Significance of the Exploratory Study

A comprehensive search has revealed that no empirical data exist regarding the effect and importance of multilingualism of an adult learner on both learning style as measured by the Kolb Learning Style Inventory and ability to solve analogies as measured by scores on the MAT. This exploratory study was intended as a first step in establishing the needed data base.

Studies have been conducted that suggest that multilingualism is positively correlated with abstract thinking skills (Cummins, 1977, 1978, 1979; Diaz, 1985; Landry, 1974; Vygotsky, 1939/1962). Multilinguals are assumed to possess an additional ability to interpret reality from alternative and supplementary perspectives (Cummins, 1977; Noonan, 1980). Thus, multilinguals are said to bring additional information and divergent insights to new situations. They are also supposedly able to extract from situations information and perceptions that are less readily available to monolinguals.

This claim for the added benefits to the multilingual is compatible with theories that emphasize the role of learning and the environment, such as Vygotsky's (1939/1962) and Luria's (1982). This position is in opposition to nativistic orientations such as Chomsky's (1967) that attributed the characteristics of linguistic and other cognitive knowledge to innate genetically determined properties. Chomsky claimed that thinking can proceed perfectly well without language, whereas Whorf (1940/1956) stated that "we dissect nature along lines laid down by our native languages" (p. 213).

Thinking and language are undoubtedly closely linked. It is possible to deduce that the serious problems of teaching deaf children result, at least in part, from their lack of language and that the symbols of language are an important tool in thinking. Luria (1959) claimed that even in the preoperational stage of thought when there may be no outward expression, the child nonetheless may be using linguistic symbols in responses of perception and inner language.

An inquiry into the relationships of language proficiency, learning style, and ability to perform on a standardized cognitive ability test raises a larger question as to the relationship between thought and language. Kolb (1976) suggested that learners develop a unique set of behaviors and attitudes, which he called learning styles, as the result of past experiences, the current environment, and heredity. He distinguished the following four learning styles in terms of modes: (a) the convergent learning style which relies primarily on the dominant learning abilities, or modes, of abstract conceptualization (AC) and active experimentation (AE); (b) the divergent learning style which emphasizes the modes of concrete experience (CE) and reflective observation (RO); (c) the assimilation learning style, in which the dominant learning abilities, or modes, are abstract conceptualization (AC) and reflective observation (RO); and (d) the accommodative learning style, which emphasizes the modes of concrete experience (CE) and active experimentation (AE).

Language is an inherent part of past experience and current environment. If it seems to provide a means of conceptualization, then language may be a determinant in the development of learning style. Thus a person who knows more than one language may develop a learning style that is different from a person who is monolingual. In addition, the particular language a person knows may affect learning style.

This study fits into the theoretical framework of the relationship between thought and language studied by both Vygotsky (1939/1962) and Luria (1959). Their studies dealt with the role of language and its relation to a person's ability to see and reconstruct analogies. Vygotsky's research increasingly demonstrated that language and perception are linked. Even in the solution of nonverbal problems, without a sound being uttered, Vygotsky viewed language as inextricably involved in the process of arriving at a solution. Language, according to Vygotsky, facilitates the generalization and categorization of experience.

As enrollment of bilinguals (especially Spanish speakers and Chinese and other Asian language speakers) in American educational institutions continues to increase, both the curriculum and the entrance requirement tests of graduate schools should reflect the needs and abilities of these students. Additionally, if learning style has some bearing on analogy test performance, then students could be taught appropriate strategies to improve test performance.

In his study of cognition and the development of language, Bever (1970) reminded us that the effects of language and cognition are mutual and that they influence each other. Perception, learning, and cognition are all integrated in human communicative behavior. The present study attempts to add to our store of knowledge about this relationship. The principal hypothesis tested in this study is that when this different segmentation occurs in the same individual, the individual's ability to solve analogies is enhanced. A highly competent bilingual would be expected to possess the linguistic and environmental perspectives of more than one culture.

Background

Researchers have addressed the issue of multilingualism and the perception of reality. The idea that one learns to visualize reality in more than one way when learning additional languages is based on Whorf's theories and principle of linguistic relativity. Whorf (1936/1956) claimed that different languages differently "segment" the same situation or experience: "We are inclined to think of language simply as a technique of expression, and not to realize that language first of all is a classification and arrangement of the stream of sensory experience which results in a certain world-order..." (p. 55).

In his investigation of language in relation to a unified theory of the structure of human behavior, Pike (1966) spoke about the different hypermeanings that come into play when dealing with two dialects or two languages. He presented the example of the translation of English "table" to the Spanish word "mesa" or the German word "tisch" which involves a hypermeaning. The correct translation can only be made in context and is not made by the routine substitution of one word for another.

Another example is the Hebrew word "lehazmin" which may mean, depending on the larger general context, "to invite" or "to reserve, order, or book." The reader needs cognitive flexibility to match the correct meaning from a list of dictionary definitions with the hypermeaning of the context. It may be inferred that this cognitive process of scanning the possibilities and choosing the most appropriate, which multilinguals do constantly, rather than being a hindrance, may be a skill that enables the individual to score well on tests of abstract thinking skills. Bilinguals are aware that the same reality may be described by different semantic fields. During the translation process, then, they may be assumed to be making choices and comparing different semantic fields. When bilinguals speak, listen, read, or write, it is possible to assume that they are engaged in more complex and additional problem-solving activities than monolinguals. If so, these activities would require higher level abstract thinking skills such as analysis, application, synthesis, and evaluation, and multilingual individuals may have the opportunity to constantly hone these skills as they shift from one language to another.

Langacker (1976) described the complexities of translating a conceived situation into linguistic terms: "...a speaker must select pertinent aspects of his current conceptual structures and cast them in a form appropriate for linguistic operations....Speaking involves submitting their conceptualizations to the exigencies of the linguistic system" (p. 322). It is possible to infer from this that possessing more than one linguistic system would make the process even more complicated, thus involving cognitive restructuring. Langacker's theoretical model has implications for the competent multilingual as more than one semantic system (one for each language that the person knows) is acquired. According to this model, the multilingual individual does not possess one semantic system with multisurface representations, one for each language, but an additional semantic system for each additional language.

Additional support for the idea that totally different languages might influence cognition in different ways is the study conducted by Tel (1984). In his examination of cognitive representation in bilinguals, Tel provided evidence for the independence hypothesis, which holds that the bilingual memory has two separate semantic representations of meanings that are accessed by two surface forms; that is, two separate semantic representations, one for each language. If a bilingual has two semantic representations, then we can infer that processing ability and cognitive flexibility of a monolingual will be extended and expanded by learning an additional language. The enhancement may be even more remarkable if the languages are totally different, such as Chinese and English.

Bilingualism is perceived to have both positive and negative effects on the first language. Cummins (1981) defined three kinds of bilingualism: limited bilingualism, partial bilingualism, and proficient bilingualism. Limited bilingualism is disadvantageous to the individual: the person is not proficient in any language and lacks cognitive academic linguistic skills in both languages. Partial bilingualism is characterized by a high proficiency in one language with a limited proficiency in the other language. High proficiency in both languages is known as proficient bilingualism and benefits the individual most.

Cummins (1978) claimed that there is an optimal threshold of language proficiency that must be passed before the cognitive advantages of bilingualism are exhibited.

Toro (1980) conducted a study on the relation of varying degrees of bilingualism to flexibility and switching ability in college students; the results of her study support the view that "the cognitive advantages of bilingualism only manifest themselves in cases where there is a relatively equal degree of proficiency between the two languages" (p. 78). The results of her study support Cummins's optimal threshold hypothesis, since only "balanced" bilinguals demonstrated superior performance on flexibility.

The contention in this study is that the balanced bilingual not only sees the world in different ways and makes additional discriminations, but that this added skill is connected to predicted academic success--or at least to the ability to solve analogies.

The concept of "balanced bilingualism," implying that a person can possess native-like ability in two languages, in an equal degree and in all areas, was developed by Macnamara (1967). His definition of a balanced bilingual was a person "equally skilled in two languages." It is agreed in the literature that a balanced bilingual is that rare person who is highly and equally competent and proficient in two or more languages.

Fishman, Cooper, and Ma (1971), however, claimed that a balanced bilingual does not really exist; the apparent balanced bilingual uses a particular language in a particular domain. They pointed out that persons who appear equally fluent in both languages are usually not equally fluent on all possible topics. Different languages are used in different situations for different functions and to converse about different topics with different people.

Dornic (1978, 1979) enlarged upon Fishman et al. and suggested that when the balanced bilingual is studied and "is scratched below the surface" in situations of tension or stress, for example, the "unbalance" bursts to the surface in language interference, language mixing, and code-switching.

Research has been conducted on the nature of language lateralization in bilinguals and multilinguals in contrast to cerebral language lateralization in monolinguals. However, conflicting findings have been described in the literature and questions are not resolved. Findings suggested that the left hemisphere in all right-handers and the majority of left-handers processed information in an analytical and sequential manner. The right hemisphere is believed to process information in a predominantly holistic, global, integrative, parallel and less-focused manner. For right-handed individuals, the left hemisphere is generally considered to be the dominant first language hemisphere, especially for syntax and phonology, whereas the right hemisphere seems to be involved in some semantic and paralinguistic activities, especially in second language acquisition. Thus, although the left hemisphere is thought to be the dominant language processing tool, the right hemisphere is active, especially when it comes to second language acquisition and bilingualism (Galloway, 1982; Galloway and Krashen, 1980; Galloway and Scarcella, 1982).

Nevertheless, these theories do not account for the effects of different intonations on meaning, nor do they explain the speaking and understanding of tone languages such as Chinese. Indeed, some researchers have discussed the dangers of "dichotomania" (Bryden, 1982; Segalowitz, 1983), wrongly ascribing various phenomena to the existence of two hemispheres in the brain in an exaggerated manner.

Much research has been conducted on the questions involving language lateralization in bilinguals (Albert and Obler, 1978; Galloway, 1982; Vaid, 1983). The findings of the research on the degree and direction of hemispheric lateralization for bilinguals' first and second languages are varied and inconclusive. It may be that different languages involve different kinds of information processing which, in turn, may involve different intrahemispheric or interhemispheric cortical structures, processes, and interventions. Thus, the outcome may be that knowledge of different linguistic systems may have an impact on cognitive flexibility.

Procedures and Methods

This investigation examined adults and used a self-report language survey questionnaire (Appendix A), the Kolb Learning Style Inventory (Appendix B), and a 100-item practice Miller Analogies Test (PMAT) (Appendix C).

The degree of language proficiency was determined from the questionnaire. Each respondent was asked which languages are known well, which languages are known superficially, and the ages at which the languages were learned.

The Kolb Learning Style Inventory measured each respondent's relative use of the four learning modes: feeling, watching, thinking, and doing. These modes reflect activities that are associated with concrete experience, reflective observation, abstract conceptualization, and active experimentation. Learning style was determined by combining learning mode scores.

The practice Miller Analogies Test (PMAT) measured the respondents' breadth of knowledge in academic subjects and the ability to solve analogies. The latter is considered to be a measure of abstract cognitive ability and, for this reason, was used in this investigation.

Statistical Procedures

Statistical analyses determined relationships that may exist between language proficiency and PMAT scores, between language proficiency and learning modes and/or styles, and between learning modes and/or styles and PMAT scores. There were four independent variables: language proficiency, learning mode, learning style, and time of learning the second language. There was one dependent variable, PMAT score. Analysis of variance (ANOVA) was used to determine differences between two language proficient groups (monolinguals/partial multilinguals and competent multilinguals) and four learning mode groups (and their accompanying styles) on PMAT scores. Chi-square tests, t-tests, ANOVAs, and Pearson product-moment correlations were used to examine strength of relationships among the variables.

Specific Considerations

Assumptions

This study was based on the following assumptions:

1. Ability to solve analogies is an indicator of abstract cognitive abilities.

2. The multilingual subjects are fully competent in the languages concerned. Informants who were considered competent multilinguals possess proficient bilingualism in at least two languages. The sample competent multilingual population was thus representative of highly bilingual individuals.

3. The analogies contained in the PMAT are very comparable to the analogies in the MAT itself; thus, if persons were to take both the PMAT and the MAT, there would be a strong, positive correlation between scores obtained on the two tests.

Methodological Limitations

Like all studies in the social sciences, this research study contained unavoidable limitations and conscious delimitations. The limitations are described below:

1. The sample was not random in the statistical sense; the subjects were primarily faculty, staff, and students on the campuses of the University of New Mexico and Albuquerque Technical-Vocational Institute who hold, as a minimum, baccalaureate degrees. Included also were a few persons from the Albuquerque community who hold baccalaureate or higher degrees. Since the population for this study were volunteers with high educational levels representing a variety of fields of interest and a wide range of socioeconomic levels, the sample population

was neither uniform nor representative of the population as a whole. As a result, the generalizability of this study is limited.

2. The competent multilingual sample was determined through answers on a self-report questionnaire. The self-report may not reflect completely accurately the respondents' ability in the languages reported.

3. There were only 17 monolinguals in the study. It was difficult to categorize such a small number of subjects into subsamples for comparison of learning mode and style.

4. Kolb's Learning Style Inventory was the complete and only basis for determining and describing subjects' preferred learning modes and styles. Other inventories may yield different results.

Delimitations

The following delimitations apply for this study.

1. Cultural influences were not considered. Language proficiency and learning style were the only independent variables. It is impossible, of course, to separate life experiences and cultural influences from the effect of language. Linguistic and cultural influences are intertwined; the cultural and socioexperiential effect on learning mode, learning style, and PMAT results cannot be isolated. Vygotsky (1960/1981) claimed that social interaction leads to the development of the child's cognitive ability and that the speech used in social interaction is internalized and becomes the social foundation of cognition. Vygotsky suggested that speech acquires the power to create intellectual functioning by being used in its instrumental capacity.

2. Attitudes toward the different languages were not considered. Researchers have found that attitudes toward the target language and the

target language community are major constituents of the affective component in second language learning (Avinor, 1980; Gardner, 1982; Gardner and Gliksman, 1982; Gardner and Lambert, 1959, 1972). The affective component was not considered, although it possibly may have an effect on cognition.

3. The sample was delimited by subjects with baccalaureate and higher degrees in order to include in the sample only highly bilingual subjects. Additionally, it was inappropriate to have prebaccalaureate subjects take the PMAT. Since the MAT was designed as an admissions tool for entry into graduate school, the breadth of knowledge and skills necessary to solve the analogies are commensurate with persons with baccalaureate degrees.

4. Only the English version of the PMAT was used in this study, although 19% of the subjects reported having native languages other than English.

Definitions and Descriptions of Key Terms

Following are operational definitions and descriptions of key terms used in this study.

Language proficiency -- Competence in a language that may range from monolingualism through partial multilingualism to proficient multilingualism. In this study, subjects were placed in one of two groups according to their language proficiency: monolinguals/partial multilinguals and competent multilinguals.

Language modality -- the written and/or oral medium of expression.

Monolingual -- A person who cannot function competently (according to the self-report questionnaire) in at least two languages. A person who was categorized as monolingual may possess a casual knowledge of a second language.

Bilingual -- a person who possesses sufficient skills in a second language to permit a significant amount of social and/or intellectual activities to be conducted through the medium of that language (Segalowitz, 1977).

Multilingual -- A person who is competent in two or more languages. Thus, a person who was categorized as bilingual, as defined above, was considered to be multilingual. The multilingual person in this study was a competent (proficient) multilingual.

Balanced bilingual -- A person who has native-like abilities in two languages. Only persons who possess proficient bilingualism (Cummins, 1976, 1981; Lambert, 1974) were categorized as balanced bilinguals. In this investigation, a subject was considered bilingual if the questionnaire responses indicated ability to function in parallel domains in each of the languages mentioned. Balanced bilingualism may include oralcy (mastery of the spoken language), literacy (mastery of the written language), or both.

Competent Multilingual -- A person who can be described as a balanced multilingual. This study assumes the existence of the "balanced bilingual" or "competent multilingual" despite the reservations of Fishman et al. (1971) and Dornic (1978, 1979). In this study, a person who has proficient bilingualism as self-reported on the questionnaire is considered to have the characteristics of a balanced bilingual and is called a "competent multilingual." These persons are contrasted, in this study, with persons who are monolingual or who possess only partial bilingualism, whom we term "monolinguals/partial multilinguals."

Monolingual/Partial Multilingual -- A person who is monolingual or who possesses only partial bilingualism.

Early Bilingual -- A person who acquired a second language before the age of 12 years.

Late Bilingual -- A person who acquired a second language at age 12 or later.

Cognition -- The process of perceiving, attending, thinking, remembering, and knowing (Blumenthal, 1977). In contrast to other definitions that might have been used, this definition includes "thinking."

Cognitive Flexibility -- A hypothetical construct that includes divergent thinking skills, abstract thinking skills and concept formation. Toro (1980) claimed that the term "cognitive flexibility" has not been explicitly and clearly defined in the bilingualism literature, but is used to explain the performance of bilinguals on various tasks.

Cognitive Style -- A hypothetical construct explaining the process of mediation between stimuli and responses. The term cognitive style encompasses the characteristic way in which individuals conceptually organize the environment (Goldstein and Blackman, 1979). This definition was supported by Harvey (1963), who defined cognitive style as referring to the way an individual filters and processes stimuli so that the environment takes on psychological meaning.

Additionally, according to Gardner, Holzman, Klein, Linton, and Spence (1959), cognitive style refers to individual consistencies in cognitive functioning over a wide range of processes. Although an individual's may have a wide range of behaviors, Gardner et al. believe that the dimensions of cognitive organization are relatively few.

Learning Mode -- A person's orientation toward learning. The four basic learning modes are Concrete Experience ("feeling"), Reflective Observation ("watching"), Abstract Conceptualization ("thinking"), and Active Experimentation ("doing") (Kolb, 1984).

Learning Style -- The description of an individual's particular learning style (accommodator, diverger, converger, or assimilator) obtained by combining scores on four basic learning modes that describe the degree to which an individual emphasizes abstractness over concreteness and action over reflection (Kolb, 1984).

Learning Style Profile -- A graphic representation of a person's relative preference for the four learning modes as plotted on the Learning Style Profile (Kolb, 1984).

Experiential Learning Model -- A model according to which learning is described in a four stage cycle. Concrete experience is the foundation for observation and reflection. The observations and reflections help create and produce new knowledge which is the basis for new implications for action. Thus new experiences are created (Kolb, 1974).

Hypotheses

The research questions are restated as the following null hypotheses:

H1. There is no significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to ability to solve analogies.

H2. There is no significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to learning mode and/or learning style.

H3. There is no significant difference in analogy-solving performance as evidenced in PMAT scores among the four learning modes and/or learning styles.

H4. There is no significant interaction between learning mode and/or learning style and language proficiency (monolingualism/partial multilingualism and competent multilingualism) with respect to the ability to solve analogies.

H5. There is no significant difference in performance on the PMAT between early competent multilinguals (those who learned the second language before age 12) and late competent multilinguals (those who learned the second language at age 12 or later).

H6. There is no significant difference in learning mode and/or learning style between early competent multilinguals and late competent multilinguals.

Organization of the Study

Chapter Two is a review of the relevant literature. Included are discussions of the research and literature on the relationships between multilingualism and cognition and between verbal analogies and cognition. The chapter also includes a discussion of the literature relating to learning styles, learning style inventories, and the Kolb Learning Style Inventory.

Methodology is discussed in Chapter Three. The research design is presented, and the characteristics of the subjects are discussed. The manner in which the subjects were categorized for language proficiency according to the responses on the self-report questionnaire is described and justified. The instruments used in the study are described and their use explained. The chapter includes a review of the use of self-report instruments in research in the social sciences. The use of the Kolb Learning Style Inventory (LSI) is discussed as it applies to this study. The Miller Analogies Test (MAT) is discussed both as a measure of ability to solve analogies and as a predictor of academic success. The chapter concludes with a statistical design and analysis and a restatement of the hypotheses.

Chapter Four contains the results obtained on the Kolb Learning Style Inventory and the practice Miller Analogies Test by each group of subjects: monolinguals/partial multilinguals and competent multilinguals. Each of the six hypotheses is examined in turn.

Chapter Five presents a summary of the results; discussion and conclusions; implications for curriculum, testing, and classroom teaching; and recommendations for further research.

CHAPTER 2

REVIEW OF THE LITERATURE

This chapter consists of a review of the literature in the following areas of importance to this study: multilingualism and cognition, verbal analogies and cognition, and learning styles.

Multilingualism and Cognition

There has been much debate on the effect of multilingualism on the individual. Early research (M. E. Smith, 1931, 1939; Thompson, 1952; Weinreich, 1963) implied negative influences of multilingualism on the individual. Smith suggested that the attempt to make use of two languages was the reason for bilinguals' poor performance on tests. Thompson claimed that the bilingual child was handicapped in his language growth. Following a review of the literature on bilingualism and cognition, Weinreich concluded that bilingualism was a source of "mental confusion" and detrimental to intellectual functioning and academic success. The investigators who saw multilingualism as detrimental based their opinions on language interference. These investigations, however, were conducted with disadvantaged, subtractive bilinguals, rather than with balanced bilinguals who had a positive concept of themselves, their language, and their culture.

The substantial influence of sociological events on learning additional languages was first proposed by Peal and Lambert (1962). They claimed that the earlier studies of bilinguals were invalid because the bilingual and monolingual subjects came from different socioeconomic backgrounds and the bilinguals were not balanced bilinguals. In the Peal and Lambert study, the bilinguals examined were the rare, balanced bilinguals, equally proficient in their two languages, and the monolingual subjects and the bilingual subjects were equivalent in their measures of socioeconomic status. Their findings contradicted those of previous studies: the bilingual children performed better than the monolinguals on both verbal and nonverbal measures. The bilingual children were superior to the monolingual children in concept formation and in tasks that required cognitive flexibility. Thus bilinguals were assumed to enjoy a certain advantage in cognitive flexibility over their monolingual counterparts, a finding also discussed by Hakuta (1987).

In his study of bilingualism as a factor in the enhancement of cognitive flexibility, Noonan (1980) defined cognitive flexibility as the ability to perceive and interpret one's surroundings from a number of perspectives with the result that an individual can bring to or take from a situation information or insight that is less available to someone else who is exposed to the same experience, and with the same opportunity to learn from it. He suggested that this additional flexibility is the result of the bilingual's practice in switching from language to language and from culture to culture.

Anisfeld (1964) compared English monolingual children and French-English balanced bilingual children on a battery of tests of cognitive flexibility. Her hypothesis was that switching between two languages enhances cognitive flexibility. Her findings were that bilinguals did not differ significantly in their scores from monolinguals.

In his investigation of divergent thinking and bilingualism, Ycas (1976) found no language effects on divergent scores when contrasting multilinguals with French and immigrant backgrounds, bilinguals, and trilinguals. He concluded that bilingualism was not associated with differences in divergent test performance. In his study, 99 monolingual and multilingual university students were administered a battery of tests: Uses of Objects and Figures, Remote Associates Test, and Advanced Progressive Matrices. Analyses of variance did not indicate significant linear or quadratic language effects on scores. Ycas concluded that bilingualism does not appear to affect performance on tests of divergent thinking.

Numerous other studies, however, demonstrated that some bilinguals performed significantly better than monolinguals on cognitive tests. Jacobs and Pierce (1965) conducted a study in which there was no control of socioeconomic factors. They found that lower socioeconomic bilingual Hispanics scored significantly lower on tests of divergent thinking skills than did monolingual Hispanics, but that upper socioeconomic bilingual Hispanics scored significantly higher than monolinguals.

Scott's study (cited in Ycas, 1976) also found that bilingual immersion students in St. Lambert, Quebec, performed significantly better than did monolinguals on tests of cognitive ability.

Balkan (1970) conducted a study in Switzerland comparing the performance of balanced bilinguals and monolinguals on nonverbal intelligence tasks and found that balanced bilinguals scored significantly higher than monolinguals on tests that measured "cognitive flexibility." He also examined the factor of "when the bilingual learned his second language" (before or after four years of age). He reported that "early bilinguals" performed significantly better than monolinguals and slightly better than "later bilinguals."

Research has been conducted on the difference between early bilingualism (acquisition of a second language before adolescence) and late bilingualism (acquisition of a second language during or after adolescence). Leopold (1939, 1947, 1949) reported the influences of early bilingualism on his bilingual daughter and found that there was language interference from English into German in lexis and syntax at a young age, but almost none in pronunciation, word forming, and morphology. No negative cognitive effects were found; the linguistic and mental development of the child were normal. Fantini (1985) reported that his early bilingual son was a proficient and competent speaker of both English and Spanish by age ten and possessed native-like abilities in both languages with no negative effects.

Genesee et al. (1978) reported that early bilinguals tend to keep the two linguistic systems separate and have less language interference than late bilinguals. Swain (1981) found that late bilinguals performed better than early bilinguals in reading comprehension tests, whereas the early bilinguals performed better in listening comprehension tasks. But when cloze tests were used as the measurement instruments in order to test grammatical competence, the early and late bilinguals were almost equal. These findings indicate that there is a transfer of skills of the older, more cognitively mature learner. Ervin-Tripp (1974) claimed that the adult second language learner pays more attention to vocabulary. She also reported that the optimal learning stage of phonology might be "around seven or eight, after learning to read" (p. 123).

Research findings on the age of second-language acquisition are ambiguous. According to Ellis (1985), the starting age affects the rate of learning: adolescent learners do better than either children or adults on grammar and vocabulary provided that length of exposure to the language is held constant. The effect of age on cognitive abilities when acquiring a second language is still being studied, however, and is as yet undetermined.

Landry (1973, 1974) suggested that children who study a second language perform significantly better on tests of divergent thinking skills than do monolingual children who do not study an additional language. The instruments employed in his studies were the Torrance Tests of Cognitive Thinking. The subjects were not balanced bilinguals, and so Landry's studies seem to be even more important, suggesting that even a partial knowledge of another language can have beneficial effects on cognitive flexibility.

This finding is in accord with Diaz (1982, 1983a and b, 1985) who claimed that most cognitive benefits for balanced bilinguals occur in the early stages. Indeed, his studies are based on data from children in kindergarten and first grade.

Diaz and Hakuta (1981) showed that among the cognitive benefits of balanced bilingual children is an awareness of the independence and appropriate separate usage of their two languages.

Carringer (1974) also found that bilinguals performed significantly better than monolinguals on the verbal and nonverbal sections of the Torrance Tests. In his study, he compared Spanish monolinguals with Spanish-English bilinguals. The subjects in Carringer's study were secondary school children in private schools, all from a high socioeconomic level, thereby providing a control for socioeconomic factors.

Also relevant to this study is an investigation by Valdesolo (1983) dealing with the impact of bilingualism on cognitive abilities.

Valdesolo found that bilingualism had a significant effect on the ability to formulate scientific hypotheses when students were highly proficient in both languages (Italian and English).

A pertinent study was conducted by Fang (1985) under the auspices of the Chinese Academy of Sciences, The Psychology Institute, Beijing, China. In an experiment on the use of classifiers by four-to-six-year-olds, Fang tested Mandarin- and Cantonese-speaking Chinese residents (34 subjects in each group) and age-matched bilingual overseas children on their ability (a) to use some common classifiers with objects shown to them in photographs, and (b) to generalize four classifiers for a group of uncommon objects.

The four-year-olds' ability to use classifiers was poor, but improved rapidly with age. The use of basic common classifiers was learned by the subjects by the end of the preschool period. A major finding was that knowledge of dialects and foreign languages had significant effects on classification ability. The development of this ability was found to be related closely to the development of abstract thinking capacity and generalization ability; that is, perceptual and cognitive development was enhanced in children who knew dialects and foreign languages.

Investigating the influence of bilingualism on cognitive development and cognitive strategy, Ben-Zeev (1972) concluded that bilingualism had specific positive effects on cognitive development in facilitating advantageous strategies of cognition and in advancing general conceptual development. In comparison with monolinguals, bilinguals demonstrated more advanced processing of verbal material, displayed more discriminating perceptual distinctions, tended to search more for structure in perceptual situations, and possessed greater capacity to reorganize their perceptions in response to feedback.

Later, Ben-Zeev (1977) hypothesized that mutual interference between a bilingual child's two languages forces the child to develop coping strategies which in some ways accelerate cognitive development. The instrument used to determine cognitive development was The Wechsler Intelligence Scale for Children (WISC), and WISC IQ was estimated from four subtests: similarities, digit span, picture completion, and picture arrangement. It was again found that despite lower vocabulary level, bilinguals performed significantly better than monolinguals in processing verbal material, in discriminating perceptual distinctions, in searching for structure in perceptual situations, and in reorganizing their perceptions in response to feedback.

According to Piaget (1926/1974), the accommodative adjustments that are required to adapt to the high structural complexity of the bilingual language situation help create a more differentiated cognitive structure. Thus, both Piaget (1926/1974) and Ben-Zeev (1972, 1977) suggested that language learning involves accommodation and the resolution of conflict and that such experience advances conceptual and cognitive development. Piaget's assimilation-accommodation models of cognitive functioning was expanded by Flavell (1985) as a model of cognitive development.

> Piaget's *assimilation-accommodation* model describes how this cognitive system interacts with its environment, and, by means of many such interactions, undergoes development change....By repeatedly attempting to accommodate to and assimilate novel, previously unassimilated environmental elements, the system itself gradually changes its internal structure--that is, cognitive development takes place (p. 10).

The inference is that bilinguals are advantaged over monolinguals. According to Feldman and Chen (1969, cited in Ben-Zeev, 1972), this implication of cognitive advantages for the bilingual seems to be true of lower socioeconomic bilingual children as well as the general population of children.

Diaz (1983a) studied the effects of learning a second language on analogical reasoning ability. His longitudinal study involved 100 Spanish-English bilingual children between the ages of five and seven. The children were asked to complete analogies. The children who scored significantly higher on the analogy test were the children with greater bilingual proficiency. Diaz also reported that progress in the second language produced additional significant increases in the children's measured analogical abilities as determined by the analogy test.

An investigation by Diaz (1985) provided support for the theory that bilingualism enhances cognitive abilities. This study of bilingual cognitive development was conducted with 100 five-to-seven-year-old, Spanish-English bilingual children, who were attending kindergarten and first grade bilingual education programs. The subjects were tested at two different times, six months apart, and their proficiency in Spanish and English was assessed together with a battery of cognitive tasks measuring visual and verbal abilities. The results suggested that the level of bilingualism is related to variability in cognitive measures only before a certain threshold of proficiency in the second language is achieved. Diaz contended that it is not until children attain a certain language proficiency threshold that most advantages in cognitive effects are demonstrated. Statistical analyses on the longitudinal data gave support to a cause-effect model in which degree of bilingualism appeared as the causal factor affecting children's cognitive abilities.

Lindholm and Aclan (1991) continued the work of Diaz (1985) by investigating the connection between academic achievement scores and degree of bilingualism, that is, academic proficiency in both English and Spanish. Their subjects included 249 students in first through fourth grade in two bilingual/immersion programs in northern California. The subjects included native speakers of both English and Spanish. In the immersion programs, students in kindergarten and first grade received 90 percent of their instruction in Spanish; second and third graders received 80 percent of their instruction in Spanish; and fourth graders received 50 percent. For the remainder of the school day, instruction was carried out in English. In the third grade, all students began reading instructions in English for the first time.

Lindholm and Aclan found that the bilingual person must develop full academic language proficiency in both languages in order for the academic advantages to accrue. Students achieved higher academic achievement scores in direct proportion to academic proficiency in both languages. Lindholm and Aclan's study amplifies the investigations of Cummins showing advantages of proficient bilingualism.

Among the research that supported the effect of language on cognition was that of Cummins. In his investigation of linguistic interdependence and the educational development of bilingual children, Cummins (1979) claimed that "a cognitively and academically beneficial form of bilingualism can be achieved only on the basis of adequately developed first language skills" (p. 222). In 1981, Cummins developed his model of the nature of language proficiency development, which he conceptualized and described as two intersecting continua; one continuum described language as being context embedded (experiential) or context reduced (learning out of context) and the other crossing continuum described language skills as being cognitively demanding (entailing cognitive manipulations) or cognitively undemanding. This model is relevant to the present study as the skills required to solve analogies are cognitively demanding and context reduced.

Bilingual education was also advocated by Edelsky et al. (1983) although they challenge some of Cummins's premises concerning testing procedures and authenticity of tasks. They agree with Cummins that older children exposed to a second language in school succeed better than younger ones. They believe, however, that this success is not due only to the development of first language skills but rather to the acquisition of linguistic and communicative skills which enable the older children to function both inside the classroom and at play with peers. Communicative competence is deemed as important as academic language ability.

A related issue is the question of the language organization in the brain of the average multilingual as opposed to that of the monolingual. Albert and Obler (1978) concluded that the language organization in the brain of the typical bilingual may be more bilateral than that of a monolingual. They even suggested that the patterns of cerebral dominance may be different for each language in the brain of the individual. These different patterns may result from the effect of the age at which the second language was learned, the manner and modality of the learning process, and of the second language itself. They suggested that bilinguals possess language skills superior to those of monolinguals. Additionally, they reported evidence that suggested that bilinguals possess enhanced cognitive flexibility and are thus better able than monolinguals to deal with abstract aspects of language. It is possible to use the contribution of Albert and Obler, showing that the language organization in the brain is different for monolinguals and multilinguals, as an explanation for different learning strategies and differences in cognitive flexibility.

Many studies claimed the cognitive assets and positive consequences of raising children bilingually. According to Vygotsky (1939/1962), the benefits are present when there is a clear demarcation between the languages; that is, when each language is associated with a specific speaker or environment. Basing their work on Vygotsky's premise, Bain and Yu (1980) studied the consequences of raising children bilingually. The longitudinal study of 88 mother-father-child triads (30 from France, 31 from Canada, and 27 from Hong Kong) employed Luria's (1982) language and cognition paradigm. The children in the triads were tested between the ages of 22 and 24 months and again between the ages of 46 and 48 months. Bain and Yu found that at the older age level, bilingual children in each group obtained significantly higher scores than children in the monolingual groups. Bain and Yu used Ronjat's (1913) "one parent, one language" method, according to which the bilingualism that developed was additive and not subtractive, and this might serve as an explanation of the method's success.

An additional study that suggested bilingualism is correlated with significantly higher scores in cognitive tests is Gowan and Torrance's (1965) investigation of children from different ethnic groups in Singapore. They found that children educated in their own language performed significantly better than children educated in English. These results are compatible with Cummins's (1976, 1977, 1979) ideas that it is beneficial to develop the native language in an additive bilingual situation.

Powers and Lopez (1985) conducted a discriminant analysis of perceptual, motor, and verbal skills of Hispanic children. Their research compared 50 monolingual and 50 bilingual (Spanish-English) four-year-olds on the motor response subscales of the Cooperative Preschool Inventory which tests knowledge of body parts, the ability to follow simple instructions and complex directions, general knowledge, and perceptual-motor coordination. The results indicated that bilingual children were superior to monolingual children in the ability to follow complex directions and in perceptual-motor coordination. These results provided supportive evidence of the beneficial effects of bilingualism.

Oren (1981) investigated the effects of bilingualism and monolingualism on the cognitive ability of children to label and relabel objects. Three different tests were developed to examine this ability in coordinate (the two languages correspond to two independent meaning systems; two semantic representations of one concept exist) and compound (the two language systems are fused; one semantic representation exists) bilingual children and in monolingual children. Forty-nine preschool bilingual and monolingual children were tested individually. Oren found that the average performance of the coordinate bilingual subjects in the labeling and relabeling tests was significantly better than that of the monolingual subjects. She also found that success on an object constancy test was significantly correlated with relabeling skills. Additionally, subjects who showed an inclination toward object classification rather than context and action classification were more flexible in dealing with words as symbols. Oren concluded that an important implication of her study was that early bilingualism is advantageous to the conceptualization of the notion of symbols.

In her position paper on bilingualism, cognitive growth, and divergent thinking skills, Fradd (1982) claimed that bilinguals have the potential for increased communication and greater problem solving.

Dulay, Burt, and Krashen (1982) suggested that there are conscious and subconscious mental processes involved in learning a second language. One of the subconscious processors used in language learning is the "filter" which "screens all incoming language" (pp. 71-72). A second-language learner may use the "filter" to select the kind of language input considered by the learner to be adequate and appropriate to the situation. With the help of the "organizer," the learner processes the language data which the "filter" lets in and gradually organizes the new language system. The second-language learner can use the linguistic knowledge gained through monitoring to consciously formulate sentences and to correct and edit his speech and writing.

In summary, the reported findings seem to suggest that there is a significant correlation between multilingualism and enhanced cognitive abilities. Most of the studies, however, were conducted with children, and there is little information in the literature on adult multilinguals and the apparent multilingual benefits on either cognitive flexibility or divergent thinking skills. Research on the relationship between multilingualism and cognition has produced inconsistent results.

Some researchers contended that multilinguals develop cognitively in the same way as monolinguals; they just progress through the respective stages more quickly. These researchers based their opinions on the work of Vygotsky (1939/1962) and Ben-Zeev (1972, 1977), claiming that multilingualism enhances metalinguistic awareness at an earlier age. According to this viewpoint, there are no significant differences in abstract thinking skills such as ability to solve analogies, or divergent thinking skills, or cognitive flexibility. There seems to be a current consensus, as opposed to earlier research, that multilingualism positively affects cognitive abilities in the child. The question now remains, "Do these benefits remain in the adult?"

Verbal Analogies and Cognition

Verbal analogies and cognition are an integral part of human intelligence. Various definitions of intelligence have recently been proposed. Intelligence has been defined in terms of cognitive structures and processes by Bourne, Dominowski, Loftus, and Healy (1986):

> How effectively a person performs in any given situation depends upon the extent to which the internal representation matches the external world and the adequacy of the program that operates on that representation. Individual differences in intelligence are to be understood in terms of differences in cognitive structures (representation) and cognitive processes (programs) (p. 364).
>
> Pattern recognition is the identification of an object as a member of a particular class. Lexical access, in which the meaning of a word is retrieved from long-term memory, is a special case of pattern recognition (p. 365).

The triarchic theory of intelligence was proposed by Sternberg (1988):

> In the triarchic theory, intelligence in everyday life has been defined as the purposive adaptation to, selection of, and shaping of real-world environments relevant to one's life and abilities (p. 65).

Sternberg's definition was expanded to include the ability to capitalize on strengths and compensate for weaknesses. The triarchic theory consists of three parts: (a) componential, relating intelligence to the internal world of the individual, (b) experiential, relating intelligence to both the internal and external worlds of the individual, and (c) contextual, relating intelligence to the external world of the individual.

Recent research has focused on defining and describing the cognitive processes involved in solving analogies. Analogical or metaphorical thinking has been defined by Williams (1983) as

> the process of recognizing a connection between two seemingly unrelated things. It does not proceed linearly but leaps across categories and classifications to discover new relationships. (It appears that these connections are probably made by the silent right hemisphere and transmitted to the left through some form of imagery.) (p. 33).

Viewing metaphor as the "language" of both hemispheres, Williams (1983) described it as "forging a connection between the abstract concept and the learner's experience" (p. 55).

Analogical reasoning has been described by Vosniadou and Ortony (1989) as involving

> the transfer of relational information from a domain that already exists in memory (usually referred to as the source or base domain) to the domain to be explained (referred to as the target domain) (p. 6).

Vosniadou & Ortony discussed three critical processes:

> first, gaining access to an (appropriate) analog; second, mapping some part of the information associated with that analog onto the target domain; and third, the side effects of analogical reasoning in terms of the production of more general rules and representations (p. 7).

Vosniadou & Ortony related these processes to a fourth general issue having to do with the relation between two distinct kinds of analogies. The between-domain (or metaphorical) analogies contain items drawn from conceptually different or remote domains, whereas the within-domain (or literal) analogies include items drawn from the same domain, or at least from conceptually close domains.

Sternberg (1977, 1988) proposed that six cognitive components are implicated in the solution of analogies: encoding, inference, mapping, application, justification, and preparation and response. The encoding component is involved in recognizing the meaning of words. The components of inference, mapping, and application are used in inferring a relationship between a pair of concepts, terms, or words. The relationship is then extended to determine if it is applicable to another pair of concepts, terms, or words. The justification component is implicated in determining which answer completes the analogical relationship that is described by the first two concepts, terms, or words. A preparation and response component is implicated in producing the solution to the analogy problem.

Sternberg (1988) used the Miller Analogies Test (MAT) as the basis for his classification. In addition, Sternberg decomposed reasoning into three elementary mental processes: (a) identifying the meaning of each of the terms of the analogy, (b) comparing the meanings of the words, and (c) responding to the analogy. Selective comparison is the recognition of a nonobvious relationship between new and old information. Componential analysis was used to decompose

> reaction times and error rates on tasks into underlying processes such as inferring relations between stimuli, mapping higher-order relations between relations, and applying previously inferred relations to new situations (p. 44).

Better reasoners were observed to be slower in identifying, and quicker in comparing than poorer reasoners. Better reasoners were also observed to prefer global planning, whereas poorer reasoners preferred local planning.

According to Sternberg (1988), no existing intelligence test measures all or even most of the skills he described. Arguing that intelligence is not a single thing but comprises a very wide array of skills, Sternberg called for a battery of assessments.

Other researchers have different classifications. Marsh and Desberg (1983) noted three stages in the development of the cognitive process: (a) rote strategy (imitation), (b) combinatorial rule which generates novel forms but may lead to overregularization errors, and (c) analogy which also generates novel forms. Examining the acquisition of children's spoken language, written language, and spelling, they argued that the process sequence was similar from one domain to another.

Pellegrino and Glaser (1982) and Sternberg (1982) suggested that the ability to solve analogies is indicative of higher-level thinking skills. The more complex the representations of information in the brain, the more highly skilled and successful the thinking process. Sternberg (1988) suggested that simpler representations of information are linked to less successful performance.

Some of the complexity of solving analogies has been described by Cormier & Hagman (1987) as including the acquisition and transfer of cognitive skills. Borrowing from other, already-mastered problem spaces, according to Cormier & Hagman, may entail negative as well as positive transfer.

The use of analogies to facilitate thinking is a complex process which students are not always able to accomplish. Vosniadou and Ortony (1989) viewed the question of how to liberate "inert" knowledge as a challenge facing research in learning and instruction:

> The issue here is not that the problem solver lacks the knowledge to solve the problem but rather that the problem solver cannot recruit that knowledge as and when it is needed (p. 13).

Cormier & Hagman (1987) believed that the complexity of an analogy in a new system affects its difficulty. "Misconceptions arise when either the preconditions or the postconditions for use of the operator in the new problem space are not yet known" (p. 193).

According to Norman (1982), the usefulness of analogies as a learning method depends on the appropriateness of the model. Learning by analogies can lead to difficulty if the analogies are flawed.

The Activation Cognition Theory (ACT), created by Anderson (1976, as cited in Bourne at al., 1986), is a simulation model which proposes a distinction between two kinds of knowledge: (a) declarative knowledge referring to facts, concepts, and beliefs, and (b) procedural knowledge referring to things that we know how to do, such as riding a bicycle. According to Cormier and Hagman (1987), the ACT predicts how examples can influence students' success in solving problems.

Some researchers, such as Martindale (1981), have emphasized the similarity in analogies. Williams (1983) gave another reason for the similarity: "It is the ability to make connections between two unlike things by recognizing that in some way they share a common trait or exemplify a common principle" (p. 56).

Similarity of analogies was described by Vosniadou & Ortony (1989) in terms of "some similarity between the target domain and source domains with respect to both their surface properties and their relationship structure" (p. 7). Similarity was considered by Vosniadou & Ortony to make the analogy easier. "The likelihood of retrieving an analog increases when surface similarity between source and target is increased" (pp. 7-8).

Problem solving has been viewed as a skill which can be taught (Bourne et al, 1986). According to Vosniadou & Ortony (1989),

> It appears that analogical learning and transfer of knowledge is facilitated when people are taught in problem-oriented learning environments as opposed to being taught facts; when the surface similarity between what is taught and the situations in which it needs to be transferred is enhanced; and when students are encouraged to take many perspectives and to look at objects from different points of view (pp. 16-17).

Williams (1983) also believed that metaphorical thinking can be taught. She criticized the traditional classrooms for leaving students to make their own connections and thus permitting failure when this process does not happen. In contrast, she advocated the training of weaker students to use strategies which their more successful classmates have intuitively discovered. Metaphor, then, was seen as the most powerful of the right-hemisphere techniques because it makes explicit the process by which learning occurs.

The importance of the effectively constructed analogy as a tool for learning has been discussed by Keane (1988). He emphasized their use in facilitating the learning of unfamiliar topics and allowing greater control in learning outcome.

The connection between creativity and analogous thinking was suggested by von Oech (1983) and by Martindale (1981). According to Martindale, "creativity involves the perception of an analogy between two or more elements" (p. 366). In addition, "A creative idea is one wherein two or more remotely associated elements (cognitive units) are seen to be similar or analogous (connected to the same superordinate unit)" (p. 367).

Problems have been classified into three types by Bourne et al. (1986): (a) analogies and series-completion problems, (b) transformation problems (change from initial state to goal state), and (c) arrangement problems (such as puzzles).

Nonverbal reasoning tests, using pictures or numbers, were considered by Sternberg (1988) to be neither culture fair nor culture free. Examinees from a test-taking culture would be assumed to have the advantage over those from a nontest-taking culture because of the need to cope with the novelty of the items and to demonstrate automatization of performance.

The issue of intelligence becomes even more confused because it is not something that people are likely to sense accurately about themselves. Sternberg (1988) found a correlation of only .23 between subjects' self-rating of their intelligence and their actual intelligence.

In summary, researchers differ in their definitions, descriptions, models, and classifications of cognitive processes and analogical reasoning. Even more problematic is the operationalization of these complex abilities in intelligence tests. Detailed descriptions of problem-solving techniques would be necessary to enable the techniques to be taught and applied as a tool to facilitate the learning of unfamiliar subjects.

Learning Styles

Most research on learning style is based on the assumption that learners possess uniquely individual attributes that are relevant to the learning process. The findings generally support a need for teachers and learners to improve their understanding of students' individual learning styles. The almost universal recommendations of learning style research are to adopt and adapt instructional modes to preferences and proclivities of learners. The contention is that when students' learning styles are matched with appropriate modes of instruction, then motivation, satisfaction, achievement, and performance will all be increased and enhanced. Thus, many inventories and tests that purport to determine learning style have been crafted. The hoped-for outcome of determining learning styles of students is the matching model of education in which instructional strategies are matched with students' propensities.

In his discussion of the cognitive movement in instruction, Wittrock (1979) defined learning style as "stable ways people differ in perception, encoding and storage of information" (p. 7). Gregorc (1979) defined learning style as consisting of "distinctive behaviors which serve as indicators of how a person learns from and adapts to his environment. It also gives clues as to how a person's mind operates" (p. 237). Cawley, Miller, and Milligan (1976) defined learning style as "the ways in which an individual selects, organizes and processes the educative experiences in the environment" (p. 103). Keefe (1979) defined learning style as "cognitive, affective, and physiological traits that are relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (p. 4).

Dunn, Dunn, and Price (1985) developed a learning style inventory that assesses the conditions under which students prefer to learn. Learner preferences are measured in the following areas: (a) immediate environment (sound, heat, light and design), (b) emotionality (motivation, responsibility, persistence, and structure), (c) sociological needs (self-oriented, peer-oriented, adult-oriented, or combined ways), and (d) physical needs (perceptual preferences, time of day, food intake, and mobility).

L. H. Smith (1976) and Renzulli and Smith (1978) developed an instrument that deals directly with common instructional techniques such as lecture vs. independent study formats. Their Learning Style Inventory (LSI) assesses the methods by which students prefer to learn subject-matter content. It is used to assist teachers in individualizing instructional programs. The LSI assesses learners' attitudes toward nine methods of instruction: projects, drills, recitation, peer teaching, discussion, teaching games, independent study, programmed instruction, and lecture. The assessment results are readily transferable into practice by teachers.

The Inventory of Learning Processes (ILP) was developed by Schmeck, Ribich, and Ramanaiah (1977) as a self-report inventory to assess learning style through a behavioral-oriented approach. The ILP was revised by Schmeck in 1981 and again by Schmeck, Geisler-Brenstein, and Cercy, in 1991. The 1991 revised ILP-R contains four major dimensions: (a) academic self-respect, the extent to which the student has formed a good, healthy concept of self-as-student; (b) reflective processing involving deep processing, elaborative processing, and self-expression; (c) agentic processing involving conventional and serial processing, and fact retention; and (d) methodological study, which measures the extent to which the student follows procedures traditionally prescribed in "how-to-study" manuals.

Schmeck (1988) preferred the phrase "learning orientation" rather than "learning styles" for referring to the strategies and tactics observed in students engaged in studying.

The School and School Work Inventory was reported in Entwistle, Kozeki, and Pollitt (1987). It was based on nine motivational categories in three major domains: (a) affective (warmth, identification, sociability); (b) cognitive (independence, competence, interest); and (c) moral (trust, compliance, and responsibility). The study contrasted two groups of secondary school pupils: four classes of British pupils (n = 614) and four classes of Hungarian pupils (n = 579). Students answered a 60-item inventory which subsequent factor analysis categorized as (a) an approach (deep/surface), (b) a style (holist, serialist), and (c) associated motivation(s) (intrinsic/fear-of-failure or instrumental/hope-for-success/conscientiousness).

> Holists were more introverted and impulsive than serialists: they were also more emotional, but less anxious. They showed more interest in theoretical and abstract complexity and in aesthetic activities. In cognitive style they were somewhat more flexible and fluent, but less reflective (p. 188).

The aim of the Entwistle et al. (1987) study was to ascertain motivational styles which would provide "information on the form of reward to which individual pupils would be likely to respond, and in fostering the development of all-round development towards mature, responsible adults" (p. 201).

The instruments described above are dissimilar in scope and emphasis, but they illustrate the direction of recent trends attempting to determine the styles used by students in learning new material and matching these learning styles with teaching styles.

Reid (1987) discussed the need to study the relationships between teaching and learning styles and developmental processes. She warned, however, that both teachers and students involved in identifying and using information on learning styles should proceed with caution and be aware that no single diagnostic instrument can solve all learning problems.

Research has been conducted on cultural differences in learning styles. Glick (1975) found that persons in industrialized societies and nonindustrialized societies responded to visual stimuli and illusions differently. From this it may be inferred that perhaps their learning styles are different, and this difference may even be related to language proficiency. Witkin (1976) reinforced these results by finding that different modes of thinking are characteristic of different cultures. The question remaining is whether different modes of thinking and learning are characteristic of different lingual groups.

In 1976, Kolb proposed that the learning process requires orientations that are polar opposites: active and reflective, concrete and abstract. The shifting orientation from one to another results in four different kinds of activity, each of which is necessary at some stage of the learning process.

From this proposition, Kolb (1976) developed a Learning Style Inventory (LSI) from which four learning abilities or modes may be identified. The self-report inventory indicates how individuals see themselves and measures individual strengths and tendencies as learners.

Kolb (1976, 1984) described stages of maturation through which an individual moves in the course of development. The stages of the preferred learning modes are as follows:

Concrete Experience -- learning from new experiences, games, role plays, etc.; peer feedback and discussion; personalized counseling (sample word, *feeling*).

Reflective Observation -- learning from lectures and from observation visualizing different perspectives on an issue; objective tests of one's knowledge of an issue (*watching*).

Abstract Conceptualization -- learning from theory readings; study time alone; clear, well-structured presentation of ideas (*thinking*).

Active Experimentation -- learning from opportunities to practice and perceive feedback; small group discussions; projects and individualized, self-paced learning activities (*doing*).

A person's individual learning style is determined from the degree to which the person emphasizes active over reflective mode, and concrete over abstract mode. Kolb (1976) called these styles accommodator, diverger, assimilator, and converger. The learning styles, their strengths, and their characteristics may be described as follows:

Divergers -- The dominant learning abilities are concrete experience (CE) and reflective observation (RO). Divergers, according to Kolb, excel in the ability to view concrete situations from many perspectives, imaginative ability, and situations that call for generation of ideas ("brainstorming"). Divergers tend to be imaginative, emotional, and interested in other people, culture, and the arts.

Assimilators -- The dominant learning abilities are reflective observation (RO) and abstract conceptualization (AC). According to Kolb, the assimilator's greatest strength is the ability to create theoretical models; thus, many assimilators tend to choose professions in the basic sciences and mathematics. The assimilator excels in defining problems, inductive reasoning, assimilating disparate observations into an integrated explanation, developing theories, and in research and planning. According to Kolb, the assimilator is not very concerned with the practical use of theories, and it is more important that the abstract theory be logically sound and precise. When a theory or plan does not fit the facts, the assimilator tends to disregard or reexamine the facts.

Convergers -- The dominant learning abilities are abstract conceptualization (AC) and active experimentation (AE). According to Kolb, the converger's greatest strength is the practical application of ideas; thus many engineers and specialists in the physical sciences are convergers. Convergers tend to do well in situations in which there is one correct answer to a question or one good solution to a problem. Convergers are relatively unemotional, prefer to deal with things rather than people, and tend to have narrow technical interests.

Accommodators -- The dominant learning abilities are active experimentation (AE) and concrete experience (CE). According to Kolb, accommodators tend to be doers and risk-takers; their strength lies in carrying out plans and experiments. They excel in adapting to new situations, and tend to discard theories and plans that do not fit the facts, as opposed to the assimilator who tends to stick with a theory or plan even if it does not fit the facts. Accommodators tend to be action-oriented and to solve problems in an intuitive trial-and-error manner, and are interested in technical or practical fields such as business.

Kolb's (1981) approach to learning style was an attempt "to integrate cognitive and socioemotional factors into an experiential learning theory" (p. 235). He emphasized the role that experience plays in the learning process. In his discussion of experiential learning, Kolb (1984) described learning as a process in which concepts are derived, created, and continuously being modified by experience. The learning process requires the continuous resolution of conflicts. Additionally, learning is a major process in adaptation to social and physical environments. Since learning is an essential adaptive process, it is not age specific, but is a lifelong continuing activity. Moreover, learning is the process of creating knowledge. Kolb defined learning as "the process whereby knowledge is created through the transformation of experience" (p. 38). His experiential theory was an attempt to explain how knowledge is created from experience.

The fact that learning styles reflect differences in perception of information and adaptation to the environment is one of the reasons that learning style was chosen as a measurement to correlate with language proficiency and cognition in this study. Kolb's (1976) model was used by Willing (1988) to examine different learning styles among adult migrants in Australia (reviewed by Baynham, 1990). As Baynham explained, Willing developed a theoretical base for the concepts of learning style and learning strategy. He linked Kolb's four dimensions (abstract conceptualization, concrete experience, reflective observation, and active experimentation) to field independence/field dependence and a personality dimension of activity and passivity in learning. The question that was not resolved was whether these differences in learning mode were natural or socially constructed.

Research on learning styles has yielded models according to which educators and methodologists would be able to adapt school curricula and thus enhance learning. Researchers used Kolb's model to examine learning style in medical specialties (Curry 1991, Plovnick, 1975). Curry applied learning mode concepts to three medical specialties with a view toward predicting and aiding in the recruitment of candidates for these specialties and the design of efficient educational programs. The Kolb LSI (1985) was one of 15 measures used. Curry found that 54 to 60 percent of the surgeons scored extremely high on the concrete experience preference for learning whereas only 27 percent of the pediatricians scored high for concrete experience. Family physicians, however, were equally dispersed across all dimensions of the Kolb LSI.

Investigating the link between career choice and learning styles, Plovnick used Kolb's LSI on medical students. Unlike Curry's subjects, Plovnick's medical students showed a bias toward abstract and active scores on the LSI. Plovnick noted, however, that he found the LSI reliability limited.

Research on learning style has developed from describing conditions under which students prefer to learn to categorizing students' attitudes and behavior during information processing. Despite the invention of various instruments measuring learning style during the past two decades, no conclusive results have been reached. Although definitions and dimensions of learning style are still being discussed, Kolb's learning Style Inventory has appeared widely in the literature. Of all of the various models, work by Kolb (1974, 1976, 1981, 1984, 1985; Kolb and Baker, 1986) has been chosen as the basis for the present research study, and his LSI is therefore a key instrument.

Convergers and Divergers: Academic Preference and Social Success

Divergers are less conforming to social norms, less restrained, and more interested in people than convergers. These personality differences are apparently related to differences in preferred choice of academic subject and in choice of profession or career. Generalizations have been made (Hudson, 1965, 1968) that differentiate between the "science man," who is reserved, impersonal, and generally convergent, and the "arts man," who is warm, flashy, impulsive, and generally divergent. Cropley (1967) found that students who were successful at academic subjects tended to be divergers. Cropley's study suggested that divergent skills are an advantage in the sciences when the answers to problems are not predetermined and fixed, but demand initiative and a breaking of established boundaries.

In contrast to Cropley, both Hudson (1965, 1968) and Roe (1970) found that convergers were academically successful and divergers were socially successful, more concerned with relationships and more emotional in their approach to problems. In his study of the most eminent American scientists, Roe claimed that the social scientists seem to be divergers whereas the physical scientists seem to be the characteristic convergers.

In the literature on convergers and divergers there are ambivalent answers to the question of the relationship between learning style and academic achievement. One question implied from the literature on this subject is whether knowledge of a second language significantly correlates with higher divergent scores. The present study may help to shed light on this issue.

Summary

The present investigation intended to determine whether multilingual adults have advantages over monolingual adults in the areas of cognitive flexibility as measured in the practice Miller Analogies Test (PMAT).

Although the present study did not deal with children, it is, to a large extent, an outgrowth of the work of Lambert (Lambert and Anisfeld, 1969; Lambert and Gardner, 1972; Lambert, Havelka, and Crosby, 1958; Lambert and Tucker, 1973). In summary, recent research on multilingualism and cognition has suggested that multilingualism may have cognitive benefits. It was suggested that multilingualism is positively correlated with cognitive flexibility and abstract thinking skills. Verbal analogies have been suggested as an instrument for measuring abstract thinking abilities. Research also suggests that there may also be a relationship between learning styles and academic success.

CHAPTER 3

METHODOLOGY

This chapter describes the research design, population and sampling procedures, and instrumentation. Included also are reviews on the use of self-reports in social science research as justification for the use of self-report instruments in this study. The Miller Analogies Test (MAT) is discussed both as a measure of the ability to solve analogies and as a predictor of academic success. The chapter concludes with a description of the statistical design and procedures of this study.

This was not an experimental study but one examining relations. Thus, no causal connections between language proficiency and cognition were sought, but rather a state of co-occurrence: finding statistically significant correlations and/or differences among language proficiency, learning modes and/or styles, and scores on the PMAT.

Adults were examined in this investigation. Their degree of language proficiency was determined from a self-reported language survey. Each respondent was asked which languages are known well, which are known superficially, and the age at which they were learned. Information on language proficiency was then related to cognitive abilities as indicated by the results on the 100-item practice Miller Analogies Test (PMAT). Both language proficiency and PMAT scores were related to learning modes and styles as determined by the Kolb Learning Style Inventory. Finally, the age at which competent multilinguals acquired the second language was related to PMAT scores and to learning modes and styles.

Additionally, this study differentiated within the multilingual population. The subjects in this study were classified into two groups by the researcher and two committee members. The groups studied were monolinguals and partial multilinguals (combined into one group termed monolinguals/partial multilinguals), and competent multilinguals (also described in the literature as "balanced bilinguals" or multilinguals).

Research Design

This study examined the influence of three independent variables: (a) language proficiency (monolinguals/partial multilinguals and competent multilinguals), (b) learning modes (concrete experience, reflective observation, abstract conceptualization, and active experimentation), (c) learning styles (diverger, converger, assimilator, and accommodator) determined from the learning modes, and (d) time of learning the second language (early vs. late) on the dependent variable, PMAT scores (analogy-solving skill). The variables are presented in Table 1. The relations between the independent and dependent variables were analyzed as well as the interrelations among the dependent variables.

Table 1. Variables

I. Dependent Variable: PMAT Scores

II. Independent Variables

- A. Language proficiency
  1. Monolinguals/partial multilinguals
  2. Competent multilinguals
- B. Learning modes
  1. Concrete experience (CE)
  2. Reflective observation (RO)
  3. Abstract conceptualization (AC)
  4. Active Experimentation (AE)
- C. Learning Styles (based on combination of learning modes)
  1. Diverger (CE and RO)
  2. Assimilator (RO and AC)
  3. Converger (AC and AE)
  4. Accommodator (AE and CE)
- D. Time of learning second language
  1. Early (before 12 years of age)
  2. Late (at 12 years of age or later)

Using the variables listed in Table 1, the purposes of the study are restated in terms of the following questions. This study attempted to determine

1. If there is a significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to ability to solve analogies.

2. If there is a significant difference between monolingual/partial multilinguals and competent multilinguals with respect to learning mode and/or learning style.

3. If there is a relationship between analogy-solving performance as evidenced in PMAT scores and the four learning modes and/or learning styles.

4. If there is any significant interaction between learning mode and/or learning style and language proficiency (monolingualism/partial multilingualism and competent multilingualism) with respect to the ability to solve analogies.

5. If there is a relationship between performance on the PMAT and the age at which a second language is learned (before or after age 12).

6. If there is a relationship between learning modes and/or styles and the age at which a second language is learned (before or after age 12).

Subjects

Respondents were chosen from a varied range of fields, from the physical and social sciences to the humanities. Moreover, the sample included people who knew more than one language. It was desirable to find respondents who were multilingual in as many different languages as possible. Respondents were either close to the B.A. or beyond it. In view of the difficulty of finding qualified respondents, it was not possible to use a more statistically appropriate sample such as randomly selected subjects or matched groups.

A primary goal in determining the procedures by which respondents were chosen was to achieve as wide a variety of respondents as possible. The preferred range would include people who were competent in more than two languages as well as people from academic areas as widely divergent as the physical sciences and the social sciences. It was also desirable to find respondents who were multilingual in as many different languages as possible. In view of the difficulty of finding qualified respondents, it was not possible to use a more statistically appropriate sample such as randomly selected subjects or matched groups.

Selection of Participants

Participants in the study were recruited one by one and in classes on the campuses of the University of New Mexico (UNM) and the Albuquerque Technical-Vocational Institute (T-VI) and, to a limited degree, from the Albuquerque community. Recruiting at UNM was through personal contact and appeals to teachers, staff, and students in the English as a Second Language (ESL) program and the Center for High Technology Materials (both with a high percentage of foreign faculty and students); the Departments of Physics, Chemistry, Speech Communication, History, Modern and Classical Languages, and Psychology; the College of Education and the Latin American Programs in Education; and International Programs and Services.

Respondents from T-VI were recruited by personal contact and through notices distributed to instructors and staff throughout the Institute. Respondents included instructors, staff, and students from developmental studies, technologies, business occupations, trades, and health occupations.

The age of the subjects ranged from 18 to 66 years. Most of them were in their late teens to early twenties.

Community respondents included a radio announcer, a staff member of the New Mexico symphony orchestra, elementary and high school teachers, a nurse, a dentist, a rabbi, a doctor, a lawyer, counselors, and housewives. Table 2 lists the occupations of the subjects.

Table 2. Description of Subjects by Occupation

Occupation	Frequency	Percent
Student	79	34.8
Educator	73	32.2
Housewife	11	4.8
Counselor	8	3.5
Administrator	6	2.6
Engineer	6	2.6
Retired person	5	2.2
Salesperson	4	1.8
Scientist	4	1.8
Clerk	4	1.8
Newsmedia Reporter	3	1.3
Technician	3	1.3
Writer	2	.9
Manager	2	.9
Contractor	2	.9
Nurse	2	.9
Health Care Worker	2	.9
Rabbi	1	.4
Soldier	1	.4
Linguist	1	.4
Consultant	1	.4
Volunteer	1	.4
Accountant	1	.4
Child Care Worker	1	.4
Social Worker	1	.4
Lawyer	1	.4
Business Person	1	.4
Computer Person	1	.4
TOTAL:	227	100.0

Students and educators were clearly the most frequent occupations, each totalling almost one-third of the sample. Far less frequent were housewives, counselors, administrators, engineers, retired persons, salespersons, scientists, clerks, newsmedia reporters, technicians, writers, and the 15 other occupations represented.

The diversity of respondents from disciplines, departments, programs, institutions, and agencies was intentional in hopes that the sample population would be relatively representative of monolinguals/ partial multilinguals and competent multilinguals who hold baccalaureate and higher degrees.

The MAT is widely used as a tool in graduate school admission decisions. As such, it is designed and normed for persons who hold at least a baccalaureate degree. Since the PMAT was selected for this study as the instrument to measure the ability to solve analogies, it was appropriate to limit the sample population to persons who have an educational background similar to those who take the MAT for graduate school admission.

One person competent in American Sign Language (ASL) in addition to English was included in the study and was classified as multilingual. ASL has distinct and syntactic characteristics; it is not simply a signed translation of English. Thus a person fluent in ASL as well as English was considered to be multilingual.

All respondents were volunteers.

Languages Known by Participants

Subjects were asked to respond to the participation request by completing the questionnaire (Appendix A) and taking the Kolb Learning Style Inventory (Appendix B) and the PMAT (Appendix C). They were then categorized by language known and age at which they acquired additional languages. The questionnaire, its interpretation, the categorization of respondents on the basis of language proficiency, and selection of subjects for the study are described in the following section on Instruments.

There were 233 respondents to the questionnaires, but six of them did not provide sufficient information to be categorized for learning style and/or language proficiency, and were therefore excluded. Thus there are 227 valid cases who are the subjects of this study.

The languages reported by the subjects appear in Tables 3 through 6. Although the native language was not English for almost 20% of the subjects, all subjects took the English version of the PMAT.

Table 3 shows the frequency of first languages among the subjects. English and Spanish are the most frequent. Hebrew and Chinese are less frequent. The remaining nine languages occur only once or twice among the subjects.

Table 3. First Language of Subjects

Language	Frequency	Percent
English	183[a]	80.6
Spanish	19	8.4
Hebrew	4	1.8
Chinese	3	1.3
French	2	.9
Navajo	2	.9
German	1	.4
Japanese	1	.4
Tamil	1	.4
Farsi	1	.4
Norwegian	1	.4
Icelandic	1	.4
Polish	1	.4
Not known[b]	7	3.1
TOTAL	227	99.8[c]

[a] Including 17 subjects who were monolingual in English.

[b] The first language is known to be other than English, but the native language is not known.

[c] Total does not equal 100.0 due to rounding.

Table 4 shows the frequency of second languages among the subjects. Spanish, French, English and German are the most frequent. Hebrew, Russian, Italian, and Chinese are less frequent. The remaining 16 languages occur only once or twice among the subjects. Seventeen subjects were monolingual in English.

Table 4. Second Language of Subjects

Language	Frequency	Percent
Spanish	95	41.9
French	34	15.0
English	31	13.7
German	12	5.3
Hebrew	7	3.1
Russian	4	1.8
Italian	4	1.8
Chinese	3	1.3
Latin	2	.9
Filipino	2	.9
Keres	2	.9
Polish	2	.9
American Sign Language	1	.4
Portuguese	1	.4
Hindi	1	.4
Thai	1	.4
Greek	1	.4
Navajo	1	.4
Malay	1	.4
Farsi	1	.4
Ute	1	.4
Krio	1	.4
Welsh	1	.4
Zuni	1	.4
None	17	7.5
TOTAL	227	99.8*

*Total does not equal 100.0 due to rounding.

Table 5 indicates that the most frequent combination of languages for multilingual subjects was English as a first language and Spanish as a second language. Of the 210 subjects who are partial multilinguals or competent multilinguals, 95 persons (45.2%) had English as their first language and Spanish as their second language. The next most frequent combination was English as the first language and French as the second (34 subjects, 16.2%). The third most frequent category was Spanish as the first language and English as the second (19 subjects, 9.0%).

Table 5. Most Frequent First and Second Language Combination for Partial and Competent Multilinguals

Combination of First and Second Language	Frequency	Percent
English-Spanish	95	45.2
English-French	34	16.2
Spanish-English	19	9.0
Other	62	29.5
Total	210	99.9*

*Total does not equal 100 due to rounding.

Table 6 shows the frequency of third languages among the subjects. Of the 227 subjects, 126 were multilingual in three or more languages. French, Spanish, German, English, and Italian are the most frequent as the third language. Yiddish, Portuguese, Latin, Hebrew, Russian, and Navajo are less frequent. The remaining 11 languages occur only once or twice among the subjects as a third language. Of the 227 subjects, 101 were monolingual or bilingual.

Table 6. Third Language of Subjects

Language	Frequency	Percent
French	34	15.0
Spanish	28	12.3
German	9	4.0
English	8	3.5
Italian	8	3.5
Yiddish	5	2.2
Latin	4	1.8
Portuguese	4	1.8
Hebrew	3	1.3
Russian	3	1.3
Navajo	3	1.3
Dutch	2	.9
Japanese	2	.9
Greek	2	.9
Arabic	2	.9
Danish	1	.4
Filipino	2	.9
Thai	1	.4
Korean	1	.4
Tewa	1	.4
Swedish	1	.4
Filipino	1	.4
Norwegian	1	.4
None	101	44.5
TOTAL	227	99.8*

*Total does not equal 100.0 due to rounding.

Language Proficiency

Categorization of the subjects by language proficiency according to native language yields the results in Table 7: 183 native speakers of English (17 of whom are monolingual) and 44 nonnative speakers of English (40 of whom are competent in English and 4 who have only partial mastery of English).

Table 7. First Language of Subjects by Language Proficiency

Group	Frequency		Percent
	Native Speakers of		
	English	Other	
Monolinguals	17	0	7.5
Partial Multilinguals	116	4	52.9
Competent Multilinguals	50	40	39.6
Totals	183	44	100.0

The distinction between monolinguals, partial multilinguals, and competent multilinguals was made according to answers on the self-report language questionnaire (Appendix A). The subjects' responses were classified by a committee of three educators (Appendix F). Subjects were classified as multilinguals if they described themselves as using the oral and/or written modality in two or more languages (questions 6-26). The competence of the subjects was determined from the extent of their use of languages in various situations (questions 10-26). Whether they learned the language early or late was determined by responses to questions 6 through 12.

It is possible for a person to be a fluent speaker of a language without being able to read or write it well. The converse can also be true; a person can become familiar with the grammar and written form of a language without being able to speak it fluently.

This study was begun with three groups of subjects in terms of language competence: monolinguals, partial multilinguals, and competent multilinguals. Because of the small number of monolinguals, however, it was useful for analysis to reclassify the subjects by collapsing them into two groups. The number of monolinguals is not large enough to justify analyzing monolinguals as a separate group. Results of the collapse are shown in Table 8.

Table 8. Language Proficiency of Subjects After Collapsing Categories Into Two Groups

Group	Frequency	Percent
Monolinguals/partial multilinguals	137	60.4
Competent Multilinguals	90	39.6
TOTAL	227	100.0

Although competent multilinguals may be considered to have acquired a second language and are therefore nonnative speakers of that language, both partial and competent multilinguals use the second language widely. The product of the learning process was some degree of fluency in the second language.

Time of Second Language Acquisition

In order to arrive at a distribution of time of language acquisition, subjects were asked about the age at which they acquired a language either/both at home and/or at school. Subjects indicated the age at which they acquired their second language.

The time at which partial and competent multilinguals (n = 210) acquired their second language is shown in Table 9.

Table 9. Cross Tabulation of Language Proficiency by Time of Second Language Acquisition

Language Proficiency/ Time	Early	Late	Row Total
Partial Multilingualism	41 34.2%	79 65.8%	120 57.7%
Competent Multilingualism	76 84.4%	14 15.6%	90 42.9%
Column Total	117 55.7%	93 44.3%	210 100.0%

Chi-square = 52.69, df = 1, p<.001

An examination of Table 9 indicates that from among the partial multilinguals, only 34.2% learned the second language before age 12, while among the competent multilinguals, fully 84.4% acquired the second language before age 12. Most partial multilinguals learned their second language later than most competent multilinguals.

Similarly, an examination of the subsample of multilingual native speakers of English (n = 166) shows that from among the partial multilinguals, only 32.8% learned the second language before age 12, while among the competent multilinguals, fully 78% acquired their second language before age 12 (see Table 10). A chi-square test indicates this is a significant difference at p<.001.

Table 10. Cross Tabulation of Language Proficiency by
Time of Second Language Acquisition for
Multilingual Native Speakers of English

Language Proficiency/ Time	Early	Late	Row Total
Partial Multilingualism	38 32.8%	78 67.2%	116 69.9%
Competent Multilingualism	39 78.0%	11 22.0%	50 30.1%
Column Total	77 46.4%	89 53.6%	166 100.0%

Chi-square = 26.97, df = 1, $p<.001$.

An examination of the subsample of competent multilinguals (n = 90) revealed that most of the 40 nonnative speakers of English (n = 37, 92.5%) learned English early (before age 12), and only 3 (7.5%) studied English late (after age 12). The time at which competent multilinguals acquired their second language appears in Table 11.

Table 11. Cross Tabulation of Native Language by
Time of Second Language Acquisition for
Competent Multilinguals

First Language/ Time	Early	Late	Row Total
English	39 78.0%	11 22.0%	50 55.6%
Other	37 92.5%	3 7.5%	40 44.4%
Column Total	76 84.4%	14 15.6%	90 100.0%

Chi-square = 2.54, df = 1, p = .11

A chi-square test indicated no significant difference between the first language and time of second language acquisition for competent multilinguals.

Language Modality

Modality was determined by subjects' use of the language according to responses on the questionnaire (questions 10, 11, 15 - 17, 21 - 23). Results in Table 12 indicate that 84 competent multilinguals used languages in both oral and written (literal) modalities, 3 were competent only in the oral modality and 3 only in the written modality. For partial multilinguals, in contrast, oral proficiency in the second language appears to have been achieved more frequently than written proficiency.

Table 12. Cross Tabulation of Language Proficiency by Modality (Oral or Written)

Language Proficiency/ Modality	Oral	Written	Both	Row Total
Partial Multilingualism	48 94.1%	7 70.0%	65 43.6%	120 57.1%
Competent Multilingualism	3 5.9%	3 30.0%	84 56.4%	90 42.9%
Column Total	51 24.3%	10 4.8%	149 70.9%	210 100.0%

Chi-square = 39.768, df = 1, p<.0001.

The chi-square test indicated a significant difference between the modalities for partial and competent multilinguals.

As indicated in Table 12, most of the subjects (70.9%) were able to communicate in both oral and literacy (written) modes. Fifty-one of the subjects were only able to speak a second language whereas 10 knew only the written form of a second language.

Instruments

All of the subjects were administered the self-report language survey questionnaire, the Kolb Learning Style Inventory, and a 100-item PMAT. The PMAT was controlled for time (fifty minutes), whereas the self-report language survey questionnaire and the Kolb Learning Style Inventory were not.

Self-Report Instruments

In his investigation of using self-reports to predict student performance, Baird (1976) examined the accuracy and the concurrent and predictive validity of brief, self-report information, and evaluated the advantages and disadvantages involved in using self-reports. After reviewing the validity of self-reported accomplishments, he believed that the validity of questions about competence, accomplishments, and achievements appears quite useful. Self-report was found to be a measure of high predictive validity in educational settings.

Ericsson and Simon (1980) contended that verbal self-reports provide authentic, valid data, especially when the subjects are requested to provide information that was directly heeded, attended to, or experienced, so that the subjects are not forced to infer.

Cohen (1984) described self-reports which complement researchers' observations by asking learners to explain the insights by which they performed linguistic tasks. He claimed that self-report data are valid and valuable.

Additionally, Holden (1985), in his investigation of test item disguise and the structured assessment of clinical psychopathology, obtained findings that indicated that the most valid results may be obtained through the use of direct questions, supporting the efficacy of self-report instruments.

Lowman and Williams (1987), in their investigation of the validity of self-ratings of abilities and competencies, examined the validity of self-estimates of ability on a vocational interest measure, SDS (Self-Directed Search: A Guide to Educational and Vocational Planning). Self-ratings of 149 female undergraduates were correlated with well-validated measures of abilities corresponding to each of six interest domains. The results suggested a pattern of high correlations between self-ratings of abilities and the objective ratings.

Self-report instruments have been found to be valuable instruments employed in a wide range of educational research (Oei and Zwart, 1986; Reed, 1984; Young, 1985). In their observational study of open education, Traub and Weiss (1982) correlated teachers' self-reports with scores given by objective outside observers. Their findings supported the conclusion that teacher self-reports may constitute valid evidence about teaching. Their study added to the justification of the use of self-report instruments in educational studies.

As one of the subjects in this study is a postsecondary school deaf individual who is bilingual in English and ASL (American Sign Language), it was decided that the use of paper and pencil self-report techniques for the assessment of personality variables would be appropriate. A study by Dowaliby (1980) of the validity and reliability of a learning style inventory for postsecondary deaf individuals indicated that paper and pencil self-report techniques for the assessment of personality variables are useful for deaf persons.

Self-Report Language Survey Questionnaire

The questionnaire used to gather data for this study was designed by the researcher and is a self-report survey of languages learned, the age at which they were learned, and situations in which the respondent is able to function using these languages. The questionnaire includes questions on the languages the respondent knows, speaks, and uses, the ages at which the languages were acquired, the manner in which they were acquired (school, home, parents, grandparents), and the current, preferred language for various activities. The questionnaire also elicits demographic information as to education, occupation, and age. A copy of the questionnaire is found at Appendix A; a copy of the Participant Consent Form is found at Appendix D.

Content Validity. The Jury Technique was employed to determine content validity of the questionnaire. Six persons (see Appendix E) were selected on the basis of their expertise and experience in education, bilingual education, second language teaching, linguistics, and bilingualism. Most jury members were selected from the University of New Mexico and the Albuquerque Public Schools. A diverse membership was sought to further underpin content validity.

The jury was asked to assess the questionnaire and to reach consensus on its adequacy as an instrument to determine language proficiency. Additionally, members were encouraged to comment and to recommend changes in the questionnaire; changes were made accordingly.

Reliability. In order to ensure interrater reliability, the categorization of respondents into the three lingual groups (monolingual, partial multilingual, and competent multilingual) was performed independently by the researcher and two other professionals (see Appendix F). One of the professionals is an expert in the field of bilingual education experienced in the classification of language proficiency; the other is an expert in applied psychology. Only those respondents on which there was unanimous classification agreement were included in the study.

A pilot study was conducted on 20 respondents in order to validate the questionnaire; the researcher and two other professional educators separately and independently categorized the respondents. There was agreement on 18 out of 20 respondents.

Specific questions that were used in categorization in the pilot study and in the research were question number 14 ("What languages do you feel you know well?") and questions such as 10 ("In what languages are you able to hold a conversation today?") and 11 ("In what languages are you able to read a newspaper?") and ("In what languages are you able to read a book 'for fun?'"). Thus, for the purposes of this study, the multilingual group consisted of subjects that were at least bilingual (and many were multilingual) according to their self-report in the language survey.

Test-Retest Reliability. A retest of the pilot subjects was performed three months after the pilot study. All of the subjects gave identical answers on the self-report language survey. These results indicated that the self-report language survey inventory has test-retest reliability.

Kolb Learning Style Inventory

This instrument (see Appendix B) has been widely used to assess individual and group learner characteristics and learning styles. Kolb (1976) designed this brief, self-report inventory as an instrument to provide both normative (between individuals) and ipsative (within individual) information regarding preferred learning styles.

The Kolb Learning Style Inventory (LSI) has been proven to be a reliable and valuable instrument for determining the learning styles of adults (Claxton and Ralston, 1978; Dunn, De Bello, Brennan, Krimsky, and Murrain, 1981; Ferrell, 1983; Kirby, 1979; Kolb, 1976, 1981).

In Kolb's (1976) Experiential Learning Model, learning is conceived as a four-stage cycle. The effective learner uses four different abilities or learning modes: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). A learner's cycle moves from experiences (CE) to reflection on those experiences from a variety of perspectives (RO) to the creation of concepts that integrate the observations into logically sound theories (AC), and finally to the use of those theories to solve problems and make decisions (AE).

The Experiential Learning Model suggests, according to Kolb (1976), that learning requires abilities that are polar opposites: concrete experience vs. abstract conceptualization and active experimentation vs. reflective observation. In the process of learning, "one moves in varying degrees from actor to observer, from specific involvement to general analytic detachment" (p. 3).

Most people, according to Kolb (1976), as a result of "our hereditary equipment, our particular past life experience, and demands of our present environment" (p. 4) develop learning styles that emphasize some learning modes over others. The learning styles defined by Kolb are the diverger, the assimilator, the converger, and the accommodator.

Kolb's (1976) LSI (see Appendix B) consists of nine sets of four words. The respondent is asked to rank order the four words in each set in a way that best describes the respondent's preferred manner of learning. One word in each set corresponds to one of the four learning modes--concrete experience (sample word *feeling*), reflective observation (*watching*), abstract conceptualization (*thinking*), and active experimentation (*doing*). In each set, respondents assign the number "4" to the word that best characterizes their preferred manner of learning, a "3" to the word that best characterizes their next preferred manner of learning, a "2" to the next preferred manner of learning, and a "1" to the word that least characterizes their manner of learning.

The LSI is scored by adding the numbers assigned by the respondent to the words that represent the four learning modes. The resulting CE, RO, AC, and AE scores may be plotted on the Learning Style Profile (Figure 1) to graphically display a person's learning preferences.

By subtracting the scores obtained on the LSI for the opposing learning modes (AE - RO and AC - CE), combination scores are obtained that reflect the degree to which a person emphasizes active experimentation over reflective observation and abstract conceptualization over concrete experience. These scores may be plotted on Figure 2, the Learning Style Type, to give a graphic representation of a person's learning style.

Figure 2 illustrates the relationships between and among the four learning styles and four learning modes. Moving clockwise on the figure from the upper-right quadrant, it is noted that the diverger makes use of learning modes concrete experience (CE) and reflective observation (RO), the assimilator makes use of reflective observation (RO) and abstract conceptualization (AC), the converger uses abstract conceptualization (AC) and active experimentation (AE), and the accommodator uses active experimentation (AE) and concrete experience (CE).

The relation between learning styles and learning modes is explained by Groetsch (1986):

> The learning style is a combination of the four basic learning modes. The learning style score of an individual is derived by using the two combination scores, AC - CE and AE - RO. These scales indicate the degree to which an individual emphasizes, respectively, abstractness over concreteness, and action over reflection. By plotting these scores on a grid, an individual can determine if his/her learning style is in the diverger (AE and RO), assimilator (RO and AC), converger (AC and AE) or accommodator (AE and CE) quadrants (p. 32).

As explained by Kolb (1976), the percentile rings on Figure 1 and the percentile scales on Figure 2 are norms obtained from a sample of 1993 adults ranging from 18 to 60 years of age. Approximately two-thirds of the sample were men and two-thirds of the sample had baccalaureate degrees or higher. The sample represented a broad range of occupations and educational backgrounds including teachers, counselors, engineers, salespersons, managers, doctors, and lawyers.

Thus, in Figure 1, 100 percent of the sample scores on the four basic learning modes fall within the 100 percentile ring; 40% of the learning mode scores fall within the 40 percentile ring. It may be noted that the percentile rings are evenly spaced; the learning mode scores are unevenly spaced.

Figure 1. Learning Style Profile

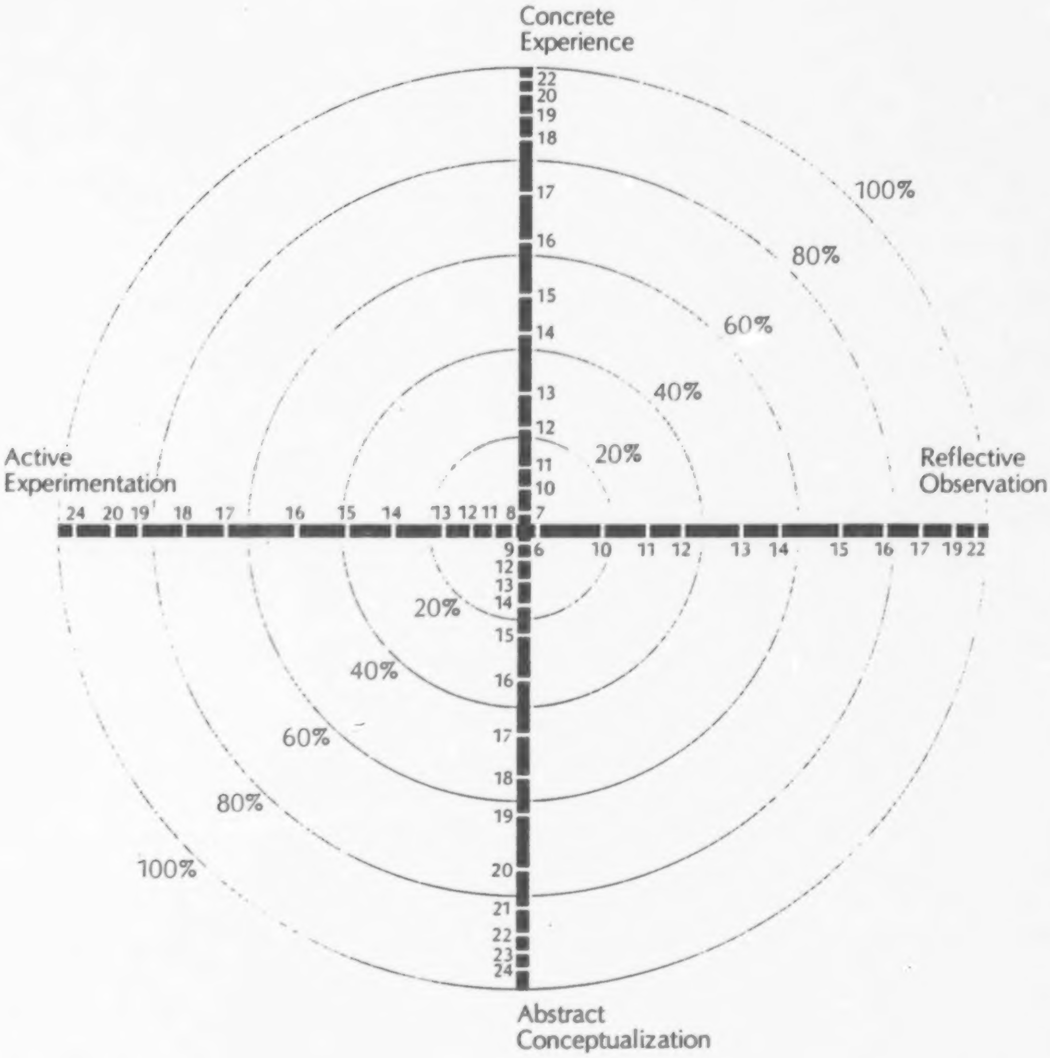
Concrete Experience
Active Experimentation
Reflective Observation
Abstract Conceptualization
100%
80%
60%
40%
20%
22 20 19 18 17 16 15 14 13 12 11 10 7
24 20 19 18 17 16 15 14 13 12 11 8
6 10 11 12 13 14 15 16 17 19 22
9 12 13 14 15 16 17 18 19 20 21 22 23 24
20%
40%
60%
80%
100%

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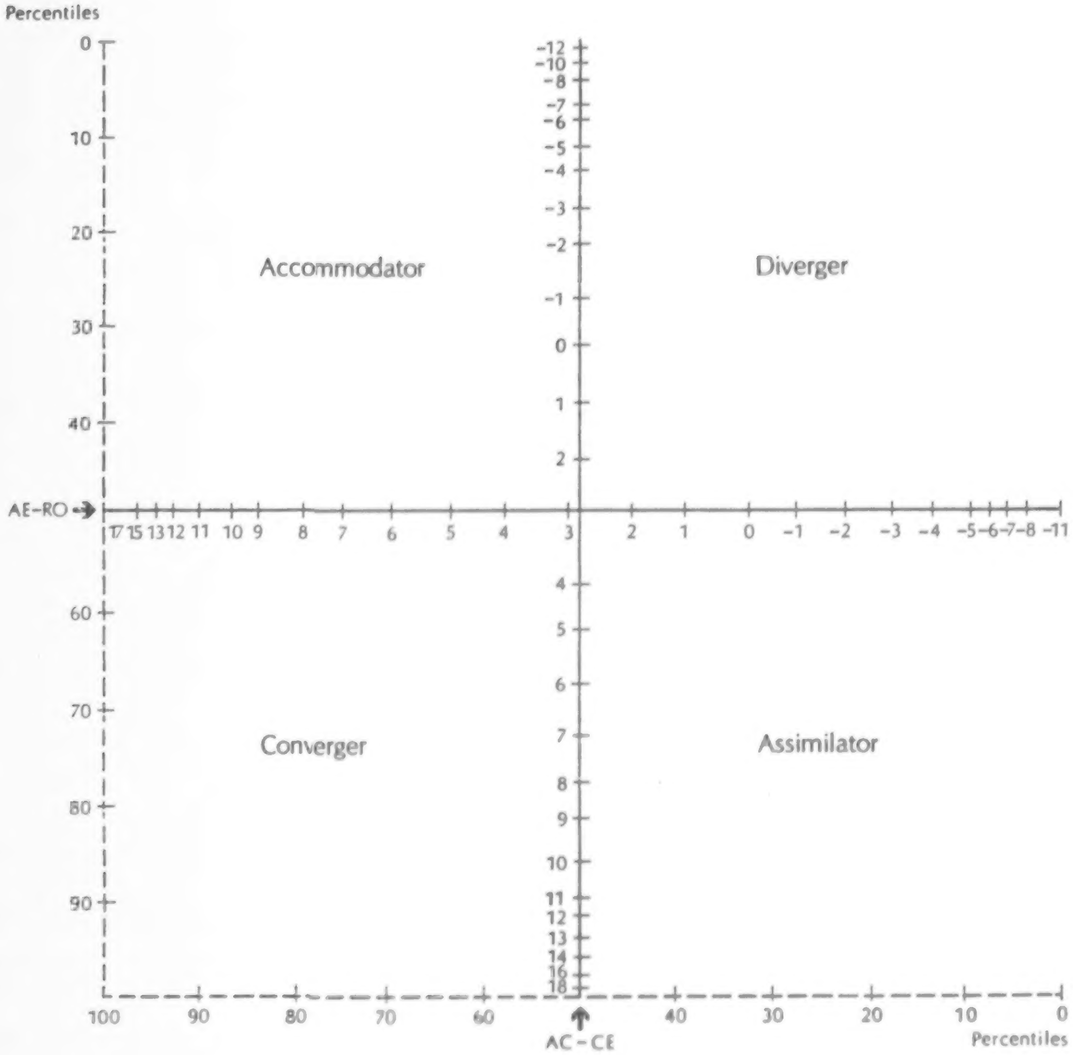
Figure 2. Learning Style Type



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Similarly with Figure 2, 50 percent of the norming sample AE - RO scores fall to the right of the 50 percentile line, 50 percent to the left. On the AC - CE score, 50 percent of the sample scores fall above the 50 percentile line, 50 percent below. As in Figure 1, the percentile scales on Figure 2 are evenly spaced; the combination scores are not.

Reliability. Kolb (1976) reported both split-half and test-retest reliability for the LSI. Spearman-Brown split-half coefficients on five groups of students and professionals on the four basic learning modes ranged from .43 to .81. Aggregating the five groups yielded the lowest coefficient for CE (.55) and highest for AC (.75). Combination scores (AC - CE) and (AE - RO) for the five groups yielded reliability coefficients of .75 to .86; aggregating the five groups yielded reliability coefficients of .74 for AC - CE and .82 for AE - RO.

Pearson correlation coefficients for test-retest reliability on four groups of students ranged from .33 to .73 for the four basic learning modes. Coefficients for the combination scores ranged from .30 to .61 for AC - CE and from .43 to .71 for AE - RO (Kolb, 1976). Kolb considered the lower reliability coefficients obtained on the test-retest lower than those obtained on the split-half reliability to be due to the respondents intervening experiences during the time between testing.

Although the reliability coefficients were generally low for the basic learning modes, Kolb (1976) considered the split-half combination coefficients to be "highly reliable indices suitable for most research applications" (p. 16).

It must be noted that the learning styles of the respondents in this study were determined from the combination scores which Kolb found had relatively high split-half reliability coefficients.

Validity. Kolb (1976) reported on correlational studies between the LSI and a variety of performance tests, personality tests, and preferences for learning situations and teachers. Most of the studies revealed only a smattering of coefficients whose probabilities were less than .05. One aptitude test (Wunderlich) with a group of industrial managers yielded coefficients with $p < .05$ for all four basic learning modes and for both combination modes. The most significant correlations, however, were found between a group of students' learning mode scores including the combination scores and the learning style of teachers who had most influenced the students. Kolb discussed the results of the studies by type of test, but did not summarize nor draw conclusions regarding the overall results.

According to Kolb (1984), the LSI has the following qualities:

1. the test is normative, allowing comparisons between subjects in their relative emphasis on a given learning mode while at the same time allowing comparisons within individuals on their relative emphasis on the four styles of learning;

2. the self-description format reflects conscious choice and decision which may reflect the respondent's learning propensities;

3. the test, so Kolb hoped, is valid--"the measures of learning styles would predict behavior in a way that was consistent with the theory of experiential learning" (p. 68); and

4. the test is brief and straightforward.

In sum, the LSI was considered appropriate for this study for the following reasons:

1. it has been used by a number of researchers in a variety of studies relating to adult learning styles;

2. the learning styles are well defined and may be easily determined from the scores on the LSI;

3. its reliability for the combination scores from which learning styles are determined, are relatively high on a split-half test;

4. it has a measure of validity; and

5. it is, as Kolb (1984) states, brief and straightforward.

Miller Analogies Test

The Miller Analogies Test (MAT) is a measure of ability to solve analogies and breadth of knowledge. It is designed as a tool in graduate school admission decisions containing subject matter relevant to students who are preparing to engage in graduate studies. Many colleges accept the MAT as a predictor of success in graduate courses.

There is no question that the MAT is a test of ability to solve analogies; the test is composed of 100 items, all in the form of analogies.

Analogies and thinking. There is considerable support for the contention that the ability to solve analogies (and specifically the MAT) is indicative of higher thinking skills. As cited by Geisinger (1985), the publisher, in its 1984 Information Bulletin, defined the MAT as a "high-level mental ability test which requires the solution of a series of intellectual problems..." (p. 414). Geisinger (1985) described the MAT as "an objectively scored...test of mental ability" (p. 414).

Both Spearman (1923) and Sternberg (1977, 1982) argued for the use of analogies in determining abstract thinking skills. In several books and articles (Sternberg, 1977, 1982, 1988; Sternberg and Nigro, 1980; Sternberg and Rifkin, 1979), Sternberg used the MAT to analyze the use of analogies and their role in assessing intelligence. He identified seven classification systems used to describe the relationships found in the MAT: similarity/contrast, description, class, completion, part/whole, equality/negation, and nonsemantic.

Validity. Citing the publisher, Geisinger (1985) states that the subject matter is taken from a variety of disciplines, such as literature, social sciences, chemistry, biology, physics, mathematics, and general information. According to Geisinger, "possession of both a good vocabulary and a wealth of general information is a necessary precondition to successful performance on the test" (p. 415).

The publisher, however, makes no claim as to content validity (Miller Analogies Test Manual, 1981). Indeed, Guilford (1967) described the subject matter as "a hodgepodge."

The test is considered to be discriminative. Geisinger (1985) stated that the test is difficult enough to have plenty of room for differentiating highly capable students. Whether the discriminative ability is due to the form of the test (analogies) or the subject matter, however, is subject to debate. Nevertheless, in the combination of analogies and subject matter, the MAT discriminates among students.

As to its ability to predict success in graduate courses and programs (and therefore its usefulness as a factor in graduate school admission decisions), the research results are mixed. Although the literature indicates that the MAT is most effective in predicting performance when used together with additional predictors such as undergraduate grade point average, this use has been questioned by Geisinger (1985).

Neither Geisinger (1985) nor Graham (1991) found the evidence for predictive validity conclusive: the unimpressive correlations between the MAT and other admissions criteria; the voluntary, biased reporting of the results of these studies; and the fact that the MAT scores may have caused or influenced admissions decisions in the first place.

Graham (1991) found a strong relationship between ethnic background and graduate school GPA (Grade Point Average) when using the MAT. Moreover, Graham found the Graduate Management Admissions Test (GMAT) score to be more strongly related to GPA than is the MAT.

Vacc and Picot (1984) studied the use of the MAT as a selection measure for admitting students to school of education doctoral programs and for identifying the variables that best discriminate between successful doctoral students (who completed programs) and those who were unsuccessful (who took at least 15 semester hours but did not complete programs). The researchers examined the records of 141 successful subjects and 11 unsuccessful subjects. Although their data showed that the MAT scores of the unsuccessful subjects were an average of 13 points higher than those of the successful subjects, these results were not enough to reject the MAT as a predictor of academic achievement. The fact that there were 141 successful subjects in one group and only 11 unsuccessful subjects in the other group raises doubts as to the validity of their investigation.

In contrast to these findings is Hochberg's (1972) investigation of the predictive effectiveness of the MAT and other variables for doctoral degree students in the School of Education at Fordham University. Hochberg found that the MAT was an effective predictor of successful completion of the doctoral program in education. High scores on the MAT were associated with the successful group of doctoral students, low scores with the unsuccessful group. None of the unsuccessful group had high MAT scores.

The predictive validity of the MAT and the Graduate Record Examination (GRE) was studied by Mehrabian (1970). He found that the MAT-GRE Index, a correlation of MAT and GRE scores, is an effective predictor of graduate performance. Furst and Roelfs (1979), who also investigated the predictive validity of the GRE and MAT tests, concluded, however, that the MAT was not useful in predicting success in doctoral programs but that the GRE was useful.

The Miller Analogies Test Manual (1981) reported evidence of the its predictive validity. Geisinger (1984) described the evidence from the manual: "it provides reports of (a) 12 correlational studies where the MAT predicts success in graduate or professional school, and (b) studies that contrast the average MAT scores of two groups" (p. 414).

A majority of the correlations are statistically significant, but many of them are not. Geisinger (1984), however, states that the MAT is a good predictor of academic success and that "the MAT correlates about as highly with criteria of graduate school performance as any other test that is frequently used" (p. 414). In 1985, Geisinger stated that the correlation of the MAT with the verbal portion of the GRE (GRE-V) is high and suggested conditions under which the MAT could be used more effectively: "The test is most likely to aid in the prediction of a criterion when the other predictor tests assess quantitative reasoning, reading, performance, IQ, or an affective variable" (p. 422).

Reliability. As a strength, Geisinger (1985) stressed the MAT's high reliability. Numerous studies, which averaged over 250 subjects, yielded reliability coefficients from .82 to .95. Geisinger noted that the publisher's test manual reported standard errors of measurement ranging from 3.7 to 4.5, based on split-half analyses. Geisinger's calculations, however, based on test-retest analysis and using his "quesstimate" of standard deviation, ranged from 5.5 to 8.25. Geisinger's considered his values to be "quite large, and could impact decision making" (p. 419).

An additional problematic issue raised by Geisinger (1985) is the possibility of improving MAT performance by training. If performance can be taught, trainability might be linked to affordability of coaching, where the more affluent students would theoretically have access to more training and become able to outperform those already disadvantaged financially. The precise impact of this practice effect, however, would be indeterminate.

Despite the mixed research results, the MAT is widely used as a prerequisite to graduate programs. According to Geisinger (1985), "the MAT is administered at more than 450 testing centers overseas, in Canada, and in 49 states of the United States" (p. 415).

> As a relatively short test of verbal reasoning, the MAT has earned a unique place for itself in the history of psychological testing and is likely to maintain itself in its respected position as a screening test that provides useful information for making graduate-admission decisions (p. 414).

Despite the controversy surrounding some aspects of the MAT, it was selected as the model instrument for this study for the following reasons:

1. the MAT is discriminative and normed;

2. the MAT is widely used for graduate school admission decisions; and

3. the subject matter comes from a variety of disciplines, including history, literature, politics, mathematics, science, and general information. The subject matter thus reflects, to a degree, the varied disciplines of the respondents in this study.

The MAT is an accepted instrument for graduate school admission throughout the world. The information it provides is specifically related to the cognitive ability. No other test was equally appropriate. This opinion is based on Sternberg who dealt with the analogy as an indicator of abstract thinking skills and with analogical reasoning processes as indicators of abstract thinking skills (Sternberg, 1977, 1982; Sternberg and Rifkin, 1979). It therefore appeared essential for the purposes of this study to use a test of analogies.

PMAT. Unfortunately, the researcher was unable to obtain permission to use the MAT itself. A practice MAT, provided by the Psychological Corporation, was used instead (see Appendix C). The PMAT is similar to the MAT in that it has the same number of items, the same format of analogies, and the same content areas. There is, however, no information available regarding statistical norms, validity, or reliability of PMAT. The PMAT was nevertheless considered preferable to other instruments which would provide less relevant information to the researcher. The PMAT was thus the best alternative available in the search for an analogy test suitable for adults.

A final note on the MAT. The MAT appears to be used indiscriminately for all applicants for graduate school without considering primary or secondary languages. Citing the manual, Geisinger (1985) reported one study where applicants for graduate school with English as a primary language performed better than those with

English as a second language. The mean scores of respondents with baccalaureate degrees in psychology, social work, and education we 56.3 and 33.3 respectively, and means scores of respondents with baccalaureate degrees in counseling education were 48.5 and 27.0 respectively.

> These findings are not desirable, especially if one imagines that the English-as-a-second-language group was largely Hispanic. The findings are even more distressing if one assumes that the English-as-a-second-language students took the Test of English as a Foreign Language and other standard admissions tests (as required by most graduate schools) because these students probably show high academic abilities with well-developed reasoning skills as well (p. 423).

Geisinger stressed the need for further research "regarding the differential performance and resultant potential adverse effects of using this test with ethnic and cultural minorities. The manual simply does not deal with the issue" (p. 423).

There have been few predictability studies of MAT scores that have controlled for primary and secondary languages. Some of the subjects in the present study are foreign students and faculty members who have learned English as a second language. The present study may thus give an indication of whether or not the MAT is an appropriate instrument for admission decisions for students whose primary language is other than English.

Research Questions

The following research questions were investigated:

1. Is there a significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to ability to solve analogies?

2. Is there a significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to learning mode and/or learning style?

3. Is there a relationship between analogy-solving performance as evidenced in PMAT scores and the four learning modes and/or learning styles?

4. Is there any significant interaction between learning mode and/or learning style and language proficiency (monolingualism/partial multilingualism and competent multilingualism) with respect to the ability to solve analogies?

5. Is there a relationship between performance on the PMAT and the age at which a second language is learned (before or after age 12)?

6. Is there a relationship between learning modes and/or learning styles and the age at which a second language is learned (before or after age 12)?

Hypotheses

The research questions stated above are restated as the following null hypotheses:

H1. There is no significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to ability to solve analogies.

H2. There is no significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to learning mode and/or learning style.

H3. There is no significant difference in analogy-solving performance as evidenced in PMAT scores among the four learning modes and/or learning styles.

H4. There is no significant interaction between learning mode and/or learning style and language proficiency (monolingualism/partial multilingualism and competent multilingualism) with respect to the ability to solve analogies.

H5. There is no significant difference in performance on the PMAT between early competent multilinguals (those who learned the second language before age 12) and late competent multilinguals (those who learned the second language at age 12 or later).

H6. There is no significant difference in learning mode and/or learning style between early competent multilinguals and late competent multilinguals.

Statistical Treatment

Statistical analyses were used to examine and to determine whether or not each of the hypotheses was supported. To determine whether differences were significant, t-tests, analyses of variance (ANOVA), chi-square tests, and correlations were used. Significance was defined by Henning (1987) as follows:

> Statistical significance, or alpha, is the probability, p, of type I error of generalizing a statistic from a sample to its population. By convention, p is usually set to be less than 0.05 to permit rejection of a null hypothesis (p. 197).

For this study, a probability of less than .05 was used to determine statistical significance.

T-tests were used to determine "whether the difference between two means was statistically significant" (Henning, 1987, p. 198). ANOVA was used for comparison of multiple groups "to test the strength of main effects and interaction effects by determining the partition of overall variance attributable to each effect and relating that to associated error variance" (Henning, 1987, p. 189).

Chi-square tests were used to show whether differences in sample groups and expected frequencies were large enough to be significant. "Chi square is a powerful non-parametric statistical procedure that is used to test independence of categorical variables or goodness of fit to mathematical expectancy models. Part of its value stems from its not assuming a normal distribution" (Henning, 1987, p. 189).

Correlations were used to determine the extent to which one variable varied with another variable. Correlations represent a "family of computational procedures used to determine the extent to which variables may be said to covary. The most common parametric version is known as Pearson product-moment correlation and is the mean cross-product of z-scores" (Henning, 1987, p. 190).

The results of the analyses are contained in Chapter Four.

CHAPTER 4

TREATMENT AND ANALYSIS OF THE DATA

The study was designed to investigate the relationship between and among language proficiency, learning mode and learning style, and a cognitive dimension, ability to solve analogy problems. The statistical procedures used to analyze the data in this chapter were selected to facilitate the testing of the null hypotheses stated in Chapters One and Three.

A t-test was used to investigate any difference that might exist between monolinguals/partial multilinguals with respect to their ability to solve analogies (Hypothesis 1). A t-test was used to study the effect of language proficiency on learning modes; a chi-square test was used to investigate the relationship between language proficiency and learning styles (Hypothesis 2). Pearson product-moment correlations were computed to determine relationships between learning modes and PMAT scores for the entire sample (Hypothesis 3) and within the two groups of language proficiency (Hypothesis 4). Similarly, relationships between learning styles and PMAT scores for the entire sample (Hypothesis 3) and by language proficiency (Hypothesis 4) were studied through analyses of variance (ANOVAs). A t-test was used to determine if a difference existed in the ability of competent multilinguals to solve analogies depending on whether the second language was learned early or late (Hypothesis 5). Similarly, a t-test was used to determine if there was a difference in the learning modes of competent multilinguals depending on early or late acquisition of the second language (Hypothesis 6). A chi-square test was used to investigate differences in learning style among competent multilinguals depending on early or late second-language acquisition (Hypothesis 6).

Since the group of monolinguals was very small (n = 17), it was combined with the group of partial multilinguals on the assumption that both groups do not have command of a second language and would therefore not be cognitively or psychologically affected by being proficient in only one language.

The sample included 227 subjects: 137 monolinguals/partial multilinguals and 90 competent multilinguals.

Each null hypothesis is restated immediately before the presentation of the relevant statistical tables. A brief narrative explanation of the results follows each table.

Hypothesis 1

H1. There is no significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to ability to solve analogies.

No significant difference in PMAT mean scores was found between monolinguals/partial multilinguals and competent multilinguals ($t(225) = -1.11$, $p = ns$; see Table 13).

Table 13. Monolinguals/Partial Multilinguals vs. Competent Multilinguals and PMAT Mean Scores: t-Test

Lingual Group	Number of Subjects	PMAT Mean Scores	Std Dev	Std Error	t	df	p
Monolinguals/ Partial multilinguals	137	51.9	17.0	1.4	-1.11	225	.267
Competent Multilinguals	90	54.6	19.4	2.0			

Hypothesis 1 regarding language proficiency and the ability to solve analogies was supported for the total sample (n = 227).

Subsidiary Analyses

Native and nonnative speakers of English. Although not a part of the analysis for H1, the respondents were further examined for native vs. nonnative speakers of English. Since performance on the PMAT is based on verbal skills and therefore requires a high level of English proficiency, nonnative speakers of English might be disadvantaged. If, however, PMAT scores also reflected cultural or interpretive mental capability, scores would not necessarily be affected.

The 227 subjects included 183 native speakers of English and 44 nonnative speakers of English. Most of the nonnative speakers of English (40 out of 44) were competent multilinguals. Because of the high percentage of nonnative English speakers among the competent multilinguals, the inclusion of nonnative English speakers could result in artificially lowered PMAT scores. Consequently, an explorative analysis was done for the subsample of native speakers of English (n = 183: 17 monolingual English speakers, 116 partial multilingual native English speakers, and 50 competent multilingual native English speakers (see Table 7, Chapter 3).

Table 14 compares the total sample population (n = 227) according to the criterion of first language rather than present multilingual competence. In this analysis, however, a significant difference is indicated between the PMAT mean scores of native and nonnative speakers of English (t(225) = 3.32, p = .001).

Table 14. Native vs. Nonnative Speakers of English and PMAT Mean Scores: t-Test

Group	Number of Subjects	PMAT Mean Scores	Std Dev	Std Error	t	df	p
Native Speakers of English	183	54.9	17.1	1.3	3.32	225	.001
Nonnative Speakers of English	44	45.1	19.4	2.9			

Native speakers of English: monolinguals/partial multilinguals vs. competent multilinguals. In an additional exploration, nonnative speakers of English appeared to add an extraneous factor. A reexamination of monolinguals/partial multilinguals vs. competent multilinguals among the native speakers of English, yields a significant difference in PMAT scores (t(181) = 3.43, p = .001; see Table 15). The competent multilingual native speakers of English performed significantly better on the PMAT than the monolingual/partial multilingual native speakers of English.

Table 15. Monolinguals/Partial Multilinguals vs. Competent Multilinguals for Native Speakers of English and PMAT Mean Scores: t-Test

Lingual Group	Number of Subjects	PMAT Mean Scores	Std Dev	Std Error	t	df	p
Monolinguals/ Partial Multilinguals	133	52.3	16.7	1.4	3.43	181	.001
Competent Multilinguals	50	61.8	16.5	2.3			

Competent multilinguals: native and nonnative speakers of English. An examination of the PMAT scores of the subsample of competent multilingual speakers of English indicates that the mean scores of the 50 native speakers of English were significantly higher than those of the 40 nonnative speakers of English (t(88) = 4.28, p = .001; see Table 16).

Table 16. Competent Multilingual Native Speakers of English vs. Competent Multilingual Nonnative Speakers of English and PMAT Mean Scores: t-Test

Lingual Group	Number of Subjects	PMAT Mean Score	Std Dev	Std Error	t	df	p
Native Speakers of English	50	61.8	16.5	2.3	4.28	88	.001
Nonnative Speakers of English	40	45.7	19.1	3.0			

The respondents who scored highest on the PMAT, then, were competent multilingual native speakers of English (see Table 15). Nonnative speakers of English received the lowest PMAT scores (see Table 14). These findings are discussed in Chapter 5.

Hypothesis 2

H2. There is no significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to learning mode and/or learning style.

Learning mode. The learning modes for the subjects were determined from scores on the LSI (see Appendix B) as discussed in Chapter 3.

An examination of learning mode scores in terms of language proficiency showed no significant differences except for the mode RO (reflective observer) and the AE-RO (active experimentation vs. reflective observation) axis. Thus, RO values were higher among monolinguals/partial multilinguals and lower among competent multilinguals.

As indicated in Table 17, competent multilinguals appear to have higher LSI scores for active learning modes and lower scores for reflective learning modes than monolinguals/partial multilinguals. Of the four learning modes, however, only the RO score is significantly different for competent multilinguals than for monolinguals/partial multilinguals (t(225) = 2.52, p<.01). Competent multilinguals have a significantly lower RO score than monoliguals/partial multilinguals.

On the AE-RO axis, the difference between monolinguals/partial multilinguals and competent multilinguals is also significant (t(225) = 2.07, p<.05) with competent multilinguals having a much higher combination score than monolinguals/partial multilinguals. Competent multilinguals favor the active experimentation mode more than do the monolinguals/partial multilinguals.

For the other learning modes, there was no significant difference between monolinguals/partial multilinguals and competent multilinguals.

Table 17. Effect of Language Proficiency on LSI Mean Learning Mode Scores

Modes	Language proficiency Group	N	Mean Scores	Stand. Dev	Stand. Error	F* value	p	t**	p
CE	mono/partial	137	16.21	3.75	.32	1.12	.56	1.41	.16
	competent	90	15.48	3.97	.42				
RO	mono/partial	137	14.52	3.86	.33	1.07	.74	2.52	.01#
	competent	90	13.22	3.73	.39				
AC	mono/partial	137	16.03	4.08	.35	1.25	.24	-.43	.67
	competent	90	16.28	4.56	.48				
AE	mono/partial	137	14.95	3.46	.30	1.33	.13	-.99	.32
	competent	90	15.44	4.00	.42				
AC-CE	mono/partial	137	-.182	6.88	.59	1.05	.77	-1.04	.30
	competent	90	.80	7.07	.74				
AE-RO	mono/partial	137	.42	6.51	.56	1.09	.67	-2.07	.04#
	competent	90	2.22	6.24	.66				

* F: df = 2,225
** t: df = 225
# significant at p<.05

Learning style. The learning styles of the subjects were determined from the combination LSI scores, AC - CE and AE - RO, as described in Chapter 3.

In the sample, as shown in Table 18, the most frequent learning style is the diverger, a person whose learning style emphasizes concrete experience (CE) and reflective observation (RO). The next most frequent types are the accommodator, a person whose learning style emphasizes concrete experience (CE) and active experimentation (AE); and the assimilator, a person whose learning style emphasizes abstract conceptualization (AC) and reflective observation (RO). The least frequent learning style is the converger, a person whose dominant learning style emphasizes abstract conceptualization (CE) and active experimentation (AE).

Table 18. Distribution of Subjects
According to Learning Style

Learning Style	Frequency	Percent
Assimilator	47	20.7
Accommodator	66	29.1
Converger	41	18.1
Diverger	73	32.2
TOTAL	227	100.1*

*Percentages do not total 100.0 due to rounding.

An examination of learning style and language proficiency showed no significant difference in terms of Kolb's learning styles of monolinguals/partial multilinguals and competent multilinguals (chi square (3) = 4.01, p = ns, see Table 19).

Table 19. Cross Tabulation of Learning Style by Language Proficiency

Language Proficiency/ Learning Style	ASSIM.	ACCOM.	CONVERG.	DIVERG.	Row Total
Monolinguals/ Partial Multilinguals	31 22.6%	38 27.7%	20 14.6%	48 35.0%	137 60.4%
Competent Multilinguals	16 17.8%	28 31.1%	21 23.3%	25 27.8%	90 39.6%
Column Total	47 20.7%	66 29.1%	41 18.1%	73 32.2%	227 100.0%

Chi-square = 4.01, df = 3, $p = .260$

Among monolinguals/partial multilinguals, there was a higher proportion of assimilators and divergers, and a lower proportion of accommodators and convergers, compared with competent multilinguals, but the differences were not significant.

Hypothesis 2 regarding the relation between language proficiency and learning style was supported.

Hypothesis 3

H3. There is no significant difference in analogy-solving performance as evidenced in PMAT scores among the four learning modes and/or learning styles.

Learning mode. Pearson product-moment correlation coefficients were calculated between PMAT mean scores and learning modes. Table 20 indicates a significant negative correlation between PMAT scores and a learning mode of RO (reflective observation) ($r = -.14$, $p < .05$, $n = 227$). Other correlations, however were not significant.

Table 20. Pearson Correlation Coefficients Between PMAT Mean Scores and Learning Mode Scores

Learning Mode	r	p	n
CE	-.06	.190	227
RO	-.14	.019*	
AC	.05	.223	
AE	-.04	.285	
AC-CE	.06	.170	
AE-RO	.06	.183	

*Significant at p <.05

Learning style. Table 21 indicates PMAT mean scores for each learning style. The PMAT mean score was 52.98 in the total sample of 227.

Table 21. PMAT Mean Scores by Learning Style

Learning Style	PMAT Mean Score	Standard Deviation	n
Accommodator	53.85	16.57	66
Assimilator	55.91	17.86	47
Converger	52.83	19.56	41
Diverger	50.40	18.40	73
TOTAL	52.98	17.99	227

ANOVA results presented in Table 22, however, show no significant differences (F(3,223) = .9702, p = ns).

Table 22. PMAT Mean Scores by Learning Styles: Analysis of Variance

Source	Sum of Squares	df	Mean Squares	F Ratio	F Prob
Between Groups	942.5008	3	314.1669	.9702	.4076
Within Groups	72211.4288	223	323.8181		
TOTAL	73153.9295	226			

Hypothesis 3 as it relates to learning modes was not supported; a significant correlation was found between PMAT scores and learning mode RO (Reflective Observation). As it relates to learning styles, however, hypothesis 3 was supported as the F statistic for testing the difference between means of the four learning styles and PMAT mean scores was not significant at the .05 level. Although not statistically significant, accommodators, assimilators, and convergers tended to have higher PMAT scores than divergers (see Table 21).

Hypothesis 4

H4. There is no significant interaction between learning mode and/or learning style and language proficiency (monolingualism/partial multilingualism and competent multilingualism) with respect to the ability to solve analogies.

Learning mode. Pearson product-moment correlation coefficients were calculated between PMAT mean scores and learning mode scores (which determine learning style). Table 23 indicates that no significant correlations were found between PMAT scores and learning modes for either monolinguals/partial multilinguals and competent multilinguals.

Table 23. Pearson Correlation Coefficients Between
PMAT Mean Scores and Learning Mode Scores
According to Language Proficiency

Language Proficiency	Learning Mode	r	p	n
Monolingual/ Partial Multilingual	CE	-.07	.207	137
	RO	-.11	.105	
	AC	-.00	.499	
	AE	-.05	.288	
	AC-CE	.04	.328	
	AE-RO	.04	.329	
Competent Multilingual	CE	-.03	.393	90
	RO	-.15	.073	
	AC	.11	.156	
	AE	-.04	.365	
	AC-CE	.09	.211	
	AE-RO	.07	.259	

Learning style. An examination of Tables 24 and 25 indicates no significant interaction between learning style and language proficiency (monolingualism/partial multilingualism and competent multilingualism) and the ability to solve analogies.

Although not statistically significant, competent multilinguals achieved higher PMAT mean scores (54.6) than did monolinguals/partial multilinguals (51.9) (see Table 24). It is also interesting to note that although the differences are not statistically significant, competent multilingual convergers received the highest PMAT mean scores (56.7), whereas monolingual/partial multilingual convergers received the lowest (48.5) (see Table 24).

Table 24. PMAT Mean Scores by Language Proficiency and Learning Styles

Language Proficiency	Learning Style	PMAT Mean Scores	Std Dev	n
Monolingual/ Partial Multilingual		51.90	17.01	137
	Accommodator	52.42	15.30	38
	Diverger	49.54	17.91	48
	Converger	51.05	20.32	20
	Assimilator	55.48	15.37	31
Competent Multilingual		54.62	19.37	90
	Accommodator	55.78	18.27	28
	Diverger	52.04	19.57	25
	Converger	54.52	19.15	21
	Assimilator	56.75	22.48	16
TOTAL		52.98	17.99	227

Table 25. PMAT Mean Scores by Language Proficiency and by Learning Styles: Analysis of Variance

Source	Sum of Squares	df	Mean Squares	F Ratio	F Prob.
Main Effects	13323.525	4	333.131	1.016	.400
Language Proficiency	390.024	1	390.024	1.190	.277
Learning Style	931.517	3	310.506	.947	.419
2-way Interactions					
Language Proficiency-Learning Style	35.621	3	11.874	.036	.991
Explained	1368.145	7	195.449	.596	.759
Residual	71785.784	219	327.789		
TOTAL	73153.930	226	323.690		

Hypothesis 4 was supported in relation to both learning modes and learning styles.

Hypothesis 5

H5. There is no significant difference in performance on the PMAT between early competent multilinguals (those who learned the second language before age 12) and late competent multilinguals (those who learned the second language at age 12 or later).

In the sample of 90 competent multilingual subjects, 84.4% learned their second language before the age of 12. For a distribution of early and late language learners for competent multilinguals, see Table 11, Chapter 3.

A t-test for competent multilinguals showed a significant difference (t(88) = -2.47, p = .015; see Table 26). Late learners received significantly higher PMAT mean scores than early learners. The significance of this finding is discussed in Chapter 5.

Table 26. Time of Second Language Acquisition for Competent Multilinguals and PMAT Mean Scores: t-Test

Time	Number of Subjects	PMAT Mean Scores	Std Dev	Std Error	t	df	p
Early	76	52.5	18.6	2.1	-2.47	88	.015
Late	14	66.1	19.9	5.3			

Students who learned a second language at age 12 or later received higher PMAT mean scores (66.1) than those who learned the second language before age 12 (PMAT mean score = 52.5). Hypothesis 5 regarding relative performance on the PMAT of early and competent multilinguals was not supported.

Hypothesis 6

H6. There is no significant difference in learning mode and/or learning style between early competent multilinguals and late competent multilinguals.

Learning mode. T-tests for learning mode scores between early and late learners of a second language show no significant difference. Results are shown in Table 27.

Table 27. Time of Second Language Acquisition for Competent Multilinguals and LSI Mean Learning Mode Scores: t-Test

Learning Mode	Time	Number of Subjects	Mean Scores	Std Dev	Std Error	t	df	p
CE	Early	76	15.5	4.0	.46	.05	88	.960
	Late	14	15.43	3.7	.98			
RO	Early	76	13.3	3.8	.44	.32	88	.751
	Late	14	15.4	3.7	.98			
AC	Early	76	16.2	4.7	.53	-.13	88	.894
	Late	14	16.4	4.1	1.09			
AE	Early	76	15.4	4.0	.46	-.06	88	.955
	Late	14	15.5	3.9	1.04			
AC-CE	Early	76	.8	7.1	.82	-.11	88	.909
	Late	14	1.0	6.9	1.86			
AE-RO	Early	76	2.1	6.2	.72	-.23	88	.821
	Late	14	2.6	6.4	1.72			

Learning style. The distribution of learning style by time of second language acquisition for competent multilinguals appears in Table 28.

Table 28. Distribution of Learning Style by time of Second Language Acquisition for Competent Multilinguals

Time/ Learning Style	ACCOMM.	DIVERGER	CONVERG.	ASSIM.	Row Total
Early	24 31.6%	20 26.3%	17 22.4%	15 19.7%	76 84.4%
Late	4 28.6%	5 35.7%	4 28.6%	1 7.1%	14 15.6%
Column Total	28 31.1%	25 27.8%	21 23.3%	16 17.8%	90 100.0

Chi-square = 1.66, df = 3, p = .646

No significant associations were found.

Hypothesis 6 regarding relative learning modes and styles of early and late competent multilinguals was supported.

Summary

Hypothesis 1 regarding language proficiency and the ability to solve analogies was supported for the total sample population. There is no significant difference between monolinguals/partial multilinguals and competent multilinguals with respect to ability to solve analogies (see Table 13).

A subsidiary analysis comparing native speakers of English vs. nonnative speakers of English indicated a significant link between native language and PMAT scores. Native speakers of English had a statistically significant advantage over nonnative speakers of English regardless of their language proficiency (see Table 14).

A second subsidiary analysis was conducted of native speakers of English. Competent multilingual native speakers of English performed significantly higher on the PMAT than monolingual/partial multilingual native speakers of English (see Table 15).

A third subsidiary analysis was conducted of competent multilinguals. Competent multilingual native speakers of English scored significantly higher on the PMAT than competent multilingual nonnative speakers of English (see Table 16).

Hypothesis 2 regarding differences between monolinguals/partial multilinguals and competent multilinguals with respect to learning mode and/or learning style was not supported.

In regard to learning modes, competent multilinguals appear to have higher LSI scores for active learning modes and lower scores for reflective learning modes than monolinguals/partial multilinguals. Of the four learning modes, competent multilinguals had significantly lower RO scores than monolinguals/partial multilinguals. On the combination score AE - RO, competent multilinguals had a significantly higher score than monolinguals/partial multilinguals (see Table 17).

In regard to learning style, there was no significant difference between monolinguals/partial multilinguals and competent multilinguals.

Hypothesis 3 as it relates to learning modes was not supported as a significant negative correlation was found between PMAT scores and learning mode RO (Reflective Observation) (see Table 20).

As it relates to learning styles, however, Hypothesis 3 was supported. Although accommodators, assimilators, and convergers tended to have higher PMAT scores than divergers, the differences were not significant (see Tables 21 and 22).

Hypothesis 4 regarding interaction between learning mode and/or learning style and language proficiency (monolingualism/partial multilingualism and competent multilingualism) on the ability to solve analogies was supported. No significant correlations were found between PMAT scores and learning modes (see Table 23).

In addition, no significant interaction was found between learning style and language proficiency (monolingualism/partial multilingualism and competent multilingualism) on the ability to solve analogies (see Table 25).

Although not statistically significant, competent multilinguals achieved higher PMAT mean scores (54.6) than did monolinguals/partial multilinguals (51.9) (see Table 24).

Hypothesis 5, regarding the ability of competent multilinguals to solve analogies and the time at which the second language was learned, was not supported. Later learners of the second language received significantly higher PMAT mean scores than early learners (see Table 26).

Hypothesis 6 relating to differences in learning mode and/or learning style between early competent multilinguals and late competent multilinguals was supported. In regard to learning mode, no significant differences were found between early and late language acquisition (see Table 27).

In regard to learning style and the time of second language acquisition, no significant associations were found (see Table 28).

The findings will be discussed and implications for classroom and teaching will be made in Chapter 5.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter includes a summary of the study, findings, discussion and conclusions, educational implications and recommendations resulting from the findings, and recommendations for further research.

Summary of the Study

The purpose of this exploratory study was to determine if there are relationships between and among multilingualism, learning mode and/or style, and the ability to solve analogies. The study originally included three experimental groups: monolinguals, partial multilinguals, and competent multilinguals. Because the sample was not random but voluntary (or quasi-random), only 17 monolinguals participated. As stated in Chapter 1 and explained in Chapter 3, because it would have been difficult to categorize such a small number of subjects into subsamples, the group of monolinguals was combined with partial multilinguals to form a single group of monolinguals/partial multilinguals. Thus the two groups studied were monolinguals/partial multilinguals and competent multilinguals.

These two groups were compared for learning mode and learning style as determined by the Kolb Learning Style Inventory and on their ability to solve analogies as measured by scores on a practice Miller Analogies Test (PMAT). The Kolb Learning Style Inventory was selected as it examines concreteness and abstractedness; action and reflection.

These characteristics may influence a person's ability to solve analogies and, moreover, may be influenced by multilingualism.

Of the 227 subjects studied, 137 were monolingual/partial multilingual. Of these, 17 were English-speaking monolinguals, 116 were partial monolingual native speakers of English and 4 were partial multilingual for whom English was a second language. There were 90 competent multilinguals, 50 of whom were native speakers of English and 40 of whom had a native language other than English. (See Table 7.)

All subjects answered a self-report language survey questionnaire according to which they were categorized in terms of language proficiency (monolingual/partial multilingual or competent multilingual). The language proficiency groups were compared for their ability to solve analogies as measured by scores on a 100-item practice Miller Analogies Test (PMAT). The relationships were also examined according to whether the second language was learned early (before age 12) or late (after age 12). The groups were also compared for learning mode (concrete experience, reflective observation, abstract conceptualization, and active experimentation) and learning style (diverger, assimilator, converger, and accommodator) as determined by the Kolb Learning Style Inventory (LSI).

The MAT is widely used throughout the world for graduate school admission. Since it was not possible to use the MAT, the PMAT was used to measure the ability to recognize analogies. For the purpose of this study, it was assumed that despite the lack of descriptive statistics, the PMAT was sufficiently similar to the MAT to give face validity to the PMAT and to yield similar results.

Findings of the Study

1. Multilingualism and PMAT Scores

For the entire sample of 227 subjects, H1 was supported: there was no significant difference in PMAT scores between the monolinguals/partial multilinguals and competent multilinguals (see Table 13).

Examination of the sample according to different populations (native and nonnative speakers of English), however, tended to support the concept that knowledge of more than one language was linked to improved analogy-solving performance. These subsidiary analyses indicated that

a. Native speakers of English attained significantly higher PMAT scores than nonnative speakers of English (see Table 14).

b. Of the native speakers of English, competent multilinguals attained significantly higher PMAT scores than monolinguals/partial multilinguals (see Table 15).

c. Of the competent multilinguals, native speakers of English attained significantly higher PMAT scores than did nonnative speakers of English (see table 16).

These findings are consistent with those of other researchers who have suggested that multilingualism is positively correlated with abstract thinking skills and cognitive development (Ben-Zeev, 1972; Carringer, 1974; Cummins, 1977, 1978, 1979, 1981; Diaz, 1983a, 1985; Landry, 1974; Scott, cited in Ycas, 1976; Segalowitz, 1977; Valdesolo, 1983; Vygotsky, 1939/1962).

The research of Toro (1980), which is consistent with the above-cited literature viewing one of the advantages of bilingualism to be the development of a "flexibility set," suggest that the advantage of bilinguals also extends to tasks requiring fast switching between languages or codes. This is consistent with the present study in that the subsidiary analyses found that competent bilinguals had an advantage over monolinguals/partial multilinguals in solving the PMAT analogies (which involves switching between source domains and target domains, i.e., switching between codes). As the PMAT (and the MAT) present analogies from many different fields of knowledge, it may be viewed as a test that requires fast switching between codes.

Associational ability is also required to perform well on the MAT. Toro (1980) found superior performance of the balanced bilingual on word association tests suggesting that the advantage of the bilinguals is closely related to enhanced associational ability. The question implied from both Toro's study and the present investigation is: Does the experience of learning a second language improve associational ability and flexibility? The answer may depend on the extent of bilingualism. In Toro's study, the unbalanced bilinguals did not differ from the monolinguals in any of the measures, suggesting that the unbalanced bilinguals did not yet reach a high enough proficiency level to experience the advantages associated with bilingualism.

Cummins (1978, 1981) spoke about a threshold of competence which needs to be achieved before the advantages of bilingualism accrue. The higher PMAT scores of the competent multilinguals may be explained not only by the practice in language switching, but by a wide range of associations in each language. The semantic features of a word in one language may overlap in part the semantic features of a parallel word in another language, but they are very rarely identical. Toro (1980) explains the superiority of bilingual children on word associations tests in terms of a larger number of associations in each memory system.

In his study with adults, Noonan (1980) found that the bilinguals retain the advantage in flexibility.

The findings also point to the advantage which multilingual native speakers of English have who are competent multilinguals. This study adds to the reports of the positive effects of multilingualism provided that an optimal threshold of language proficiency has been achieved (Cummins, 1978, 1981; Fang, 1985; Toro, 1980).

Native speakers of English would appear to have the advantage of being comfortable in English, the majority language of the country and the language in which the PMAT and the questionnaires were administered. As shown in Table 5, a large number of multilingual native speakers of English noted Spanish as a second language. Aside from the purely linguistic and cognitive issues, there may be socioeconomic and sociolinguistic factors in the sample population which were beyond the scope of the present study. Further research, however, would be necessary to ascertain the nature of the link.

Generalized inferences from this study, however, cannot be made because there were not enough subjects in any second-language group to find significant differences on the PMAT scores. For the native speakers of English, however, multilingualism was shown to help, not hinder, cognitive thinking. The argument that multilingualism results in language interference which is detrimental to cognitive ability (as stated, for example, by Ferguson and Huebner, 1980) appears to be false.

2. Multilingualism and Learning Modes and/or Learning Styles

For the sample population of 227 subjects, there was no significant difference between levels of language proficiency in mean learning mode scores except for RO (reflective observation), where RO values were significantly lower for competent multilinguals than for monolinguals/partial multilinguals (see Table 17).

The learning styles of monolinguals/partial multilinguals and competent multilinguals were not found to be significantly different. Among monolingual/partial multilingual subjects, there was a higher proportion of assimilators and divergers, and a lower proportion of accommodators and convergers, compared with competent multilinguals, but the differences were not significant (see Table 19). Hypothesis 2, therefore, was supported.

The finding of a higher proportion of convergers among the competent multilinguals is consistent with the work of Ben-Zeev (1972). She claimed that the bilingual makes an effort to discover order in the environment and structure in the verbal environment. This constant search for order and structure may become a cognitive trait. Convergers, who tend to organize and look for order, may have a focused, task-oriented strategy.

3. PMAT Scores and Learning Modes and/or Learning Styles

Although there was a significant negative correlation between learning mode RO (reflective observation) and PMAT scores for the 227 subjects (Table 20), no significant differences were found between subjects' PMAT scores and their learning styles (Table 22). Thus, Hypothesis 3 was supported for learning styles but not for learning modes.

These results are in keeping with the contradictory findings of Cropley (1967), Hudson (1965, 1968), and Roe (1970). On the one hand, Cropley found that divergers were inclined toward academia and the sciences. Both Hudson and Roe, on the other hand, found that divergers were socially rather than academically successful. Learning style alone would not appear to account for these preferences.

4. Multilingualism, Learning Modes and Learning Styles, and PMAT

There was no significant interaction effect of language proficiency and learning modes or style with respect to analogy-solving abilities (see Tables 23 through 25). Competent multilinguals received higher PMAT scores than did monolinguals/partial multilinguals regardless of learning style (see Table 24), but this difference in PMAT scores was not significant.

Thus, Hypothesis 4 was supported in relation to both learning mode and learning style.

This finding is similar to the conclusion of Ycas (1976) that multilingualism did not affect performance on tests of divergent thinking.

5. Early vs. Late Multilingualism and PMAT Scores

The age at which a competent multilingual learns a second language was linked with the ability to solve analogies. Competent multilinguals who acquired their second language late (at age 12 or later) achieved significantly higher PMAT scores than did those who learned a second language before the age of 12 (see Table 26). Hypothesis 5 was therefore not supported. This finding is different from the conclusion of Balkan (1970), who found that early bilinguals performed better than late bilinguals, but similar to that of Swain (1981), who found that late bilinguals performed better than early bilinguals on reading comprehension tests.

6. Early vs. Late Multilingualism and Learning Modes and Learning Styles

The age at which a competent multilingual learns a second language was not linked with learning mode or learning style. Learning mode and learning style distributions were similar whether the subjects had learned a second language before age 12 or at age 12 or later (see Tables 27 and 28). Thus Hypothesis 6 was supported.

Discussion and Conclusions

Multilingualism and PMAT Scores

Multilingualism has been positively correlated with abstract thinking skills by Bever (1970), Cummins (1976), Diaz (1983b, 1985), Landry (1973, 1974), Luria (1971), and Vygotsky (1981). Their findings, demonstrating that competent bilinguals performed significantly better than monolinguals on cognitive tests, were supported by the present study in which, among native speakers of English, competent multilinguals scored significantly higher on the PMAT than monolinguals/partial multilinguals (see Finding 1). This finding may not be concerned only with linguistic knowledge.

One of the research questions of this study was to determine whether adult monolinguals/partial multilinguals and competent multilinguals differ significantly in performance on a test examining analogy-solving ability. It is the contention of this researcher that habitually judging and evaluating (both consciously and unconsciously) the incoming messages and the appropriate responses enhance cognitive flexibility. It is assumed that repeated code-switching may induce cognitive conflict that, in turn, will result in cognitive restructuring and growth. Piaget (1974) suggested that cognitive conflict and problem solving enhance thinking ability and learning.

Acquisition of an additional language may entail breaking a language barrier or some other kind of cognitive barrier, and may constitute a cognitively qualitative, as well as quantitative, linguistic leap. Multilinguals who have crossed the language barrier, may have opened the door to new cognitive potentials.

Pike (1966) suggested that multilinguals are constantly engaged in the cognitive process of scanning various possibilities and choosing the most appropriate. Such daily problem-solving activity would give multilinguals more practice in complex abstract skills than the average monolingual.

Another aspect of the link between multilingualism and abstract thinking is the linguistic similarities or differences (closeness or distance) between the languages acquired or learned by an individual. The leap between English and Spanish, for example, may be less drastic than that between English and Chinese where spoken tonality and written characters differ from English in both oral and written modalities. The most frequent language combination in the present study was English and Spanish. It is possible that other language combinations would have yielded different results.

Multilingualism, Learning Mode, and Learning Style

In terms of learning mode, RO values were significantly higher among monolinguals/partial multilinguals and lower among competent multilinguals. Although the actual differences in RO scores is very small, it is nevertheless significant. Is the learning mode of reflective observation linked with lack of experience or uncertainty?

Is it possible that people who need to stop and think at the beginning of a language learning task slowly become more practiced and confident so that by the time they are competent multilinguals, they no longer find it necessary to engage in this learning mode? Further research is necessary to follow through on this line of reasoning.

Different learning styles did not appear to be significantly different for various language experiences. Some general trends were noted, however. Accommodators, for example, were most frequent among competent multilinguals. Accommodators are doers and risk-takers who adapt easily to new situations. In contrast, divergers, who view situations from many perspectives, were more frequent among monolingual/partial multilingual subjects.

RO Learning Mode and Lower Mean PMAT Scores

There was no apparent connection between learning mode and PMAT scores except for the RO (reflective observer) learning mode, which was linked with lower PMAT scores (see Finding 3). Since reflective observers may have taken longer to consider each question, this type of learning mode was disadvantageous possibly because the PMAT (and the MAT) is a speed test requiring quick responses for higher scores. Being a speed test, the MAT would not allow the slower, reflective learning-mode person to realize his full potential on a test. Conceptual tempo appears to be a factor determining success on a speed test.

Learning Mode/Learning Style, Language Proficiency, and PMAT Scores

No significant interaction was found between mode and style of learning and language proficiency with respect to the ability to solve analogies. In the diversity of language modes and styles, it is possible that various tendencies would cancel each other out in the statistical analysis. A further study would be indicated using larger samples of subjects belonging to each classification of learning style and mode.

Early/Late Time of Second Language Acquisition and PMAT Scores

The existence of adolescence as a critical age for language development is controversial. Nevertheless, results of this study indicate a difference in analogy-solving skill linked to age of second language acquisition.

Time is linked to level of language proficiency and cognitive ability in that competent multilinguals who acquired a second language late (at or after age 12) received higher PMAT scores than competent multilinguals who acquired a second language early (see Finding 5). On the other hand, no link was found between time of second language acquisition and learning mode and/or learning style. Thus there is no simple link among time, language proficiency, and PMAT scores.

Acquisition of a second language after the age of 12 appears to be more efficient in terms of performance on a cognitive test such as the PMAT than learning a second language before the age of 12. Although it would be expected that language learning before age 12 would also be linked to higher PMAT scores, such was not the case. Persons who acquired the second language after the age of 12 achieved higher PMAT scores. What is not clear, however, is whether this finding is a cause or an effect. That is, were the PMAT scores higher as a result of superior linguistic training when students acquired the second language after age 12, or did children who learned a second language before age 12 come from socially, economically, and/or educationally disadvantaged homes and therefore receive lower scores on the PMAT? Learning a second language may be such a difficult enterprise that one has to be equipped with superior cognitive test-taking skills in order to achieve this feat at a later age.

The evidence is still inconclusive. In terms of arguments in favor of acquiring a language either early (before age 12) or late (after age 12), most studies found different characteristics for different learners. The very young may show some limited language interference (Leopold, 1939, 1947, 1949), but not necessarily more so than late language learners (Genesee et al., 1978). The early learner may excel at phonological accuracy and listening comprehension, whereas the late learner may do better in vocabulary learning and reading comprehension (Ellis, 1985; Ervin-Tripp, 1974; Swain, 1981).

Dulay, Burt, and Krashen (1982) differentiated between "acquisition" and "learning." Acquisition consists of the spontaneous process of rule internalization that results from natural language use (as children acquire their native language), whereas learning consists of the development of conscious knowledge of a second language through formal study.

Among partial and competent multilinguals, there is a significant difference between early and late language learners (see Table 9). Most partial multilinguals learned their second language later than most competent multilinguals. One may infer from this finding that most people who are competent multilinguals started learning the new language at an early age. There are researchers who recommend teaching languages at an early age (Bain and Yu, 1980; Fantini, 1985). It is recommended, therefore, that formal language learning be started before age 12 in order to achieve maximum competence.

In order to progress in formal learning situations and to succeed academically, language learning is necessary. Learning occurs as a result of formal study wherein the learner focuses on the formal properties of the second language.

Learning Mode/Style and Time of Language Acquisition for Competent Multilinguals

There was no significant difference between learning mode and/or style and time of language learning for competent multilinguals. This finding may result from small samples canceling out tendencies which are opposing and equally strong. Further research using larger samples and more precise instruments to measure language proficiency may resolve this methodological problem.

Sampling

There were not enough subjects in any second-language group to perform a statistical test to determine whether or not there was a significant difference between the performances on the PMAT of each language group. Although subjects in a few second-language groups achieved low scores on the PMAT, none of these groups had a large enough number of subjects to permit generalized inferences.

Moreover, because of the difficulty of obtaining suitable qualified subjects for the study, the sample was neither randomly selected nor matched, but consisted of people close to or with a B.A. or B.S. in the Albuquerque community.

In the present study, occupational groups were not compared. Kolb (1984) discussed the relationships of learning styles and professional careers and jobs. Kolb stated that when academic disciplines are examined in four major groupings--the social professions, science-based professions, humanities/social sciences, and natural science/mathematics--it becomes apparent that what constitutes valid knowledge in these groups differs, and variations in learning styles is evident. Analysis according to learning style and academic discipline might have had impact on the results of the study.

Gender was not investigated in the present study; gender was not asked in the self-report questionnaire. The relationship between gender and learning style might have revealed added information.

Educational Implications

Curriculum

Education in the United States has been criticized because of the high rate of illiteracy as described in reports such as "A Nation at Risk" (National Commission on Excellence in Education, 1981). One solution proposed is that of the "Back to Basics" movement, emphasizing mathematical and language skills. It is possible to take this one step further. Knowledge of multiple languages appears to be linked with enhanced cognitive ability as measured by test performance.

Other curricular implications that emerge from this study deal with (a) the advisability of learning a foreign language in order to increase cognitive flexibility, and (b) the age at which a foreign language can be introduced into the curriculum with maximum speed and efficiency.

Problem solving has been viewed as a skill which can be taught (Bourne et al., 1986; Keane, 1988; Segalowitz, 1977; Vosniadou and Ortony, 1989; Williams, 1983). If it is possible to train students to improve their MAT scores, as Geisinger (1985) claims, then abstract thinking skills may not be absolutely predetermined. To improve these skills, it is recommended that examples of analogies and models of MAT-like questions be included in the curriculum, even as early as elementary school. Although this may be an implicit criticism of the MAT, it is also an inherently optimistic approach to the possibility of improving cognitive skills and flexibility through education.

The findings of this study related to age of second-language acquisition present a paradox. Table 9, Chapter 3, indicates a significant difference between age of second-language acquisition and language proficiency: more than 84% of the competent multilinguals in this study learned the second language prior to age 12 whereas almost 66% of the partial multilinguals acquired the second language after age 12.

Among the competent multilinguals, as revealed in Table 26, Chapter 4, those who learned the second language after age 12 scored significantly higher on the PMAT than those who learned the second language before age 12.

Thus, if the goal is language competence, students should be encouraged to learn a second language before age 12. If the goal is to enhance cognitive ability as measured by tests, students should begin acquiring a second language before age 12 and continue to formally study the language after age 12.

Multilingual Native vs. Nonnative Speakers of English and the MAT

The findings from this study have implications as to using the MAT to test multilinguals. Since most nonnative speakers of English were competent multilinguals, it is logically inconsistent that their scores on the PMAT were not as high as those of their peers who are native speakers of English (see Finding 1). Learning styles, which were similar for both native and nonnative English speakers, did not account for the difference in scores.

Since the researcher was unable to obtain permission to use the MAT, a practice MAT, provided by The Psychological Corporation, was used instead. The PMAT used in this study may not be equivalent to the MAT, and the results, if applied to the MAT, may therefore be skewed. The PMAT, however, contained some items that would not be readily known by a person unfamiliar with western culture.

Following are sample items from the PMAT which this investigator considers to be problematic, not being based on general knowledge. For example, the examinee needs to be familiar with the specific fields of knowledge presupposed in items number 5 and 41, and must be aware of Western (in contrast with Eastern) cultural trends for items number 24 and 37.

5. A.W.O.L. : SOLDIER :: (a. expelled, b. tardy, c. truant, d. suspended) : STUDENT

24. CANDIDE : VOLTAIRE :: (a. Pirandello, b. Cid, c. Quixote, d. Lazarillo) : CERVANTES

37. PRESTO : (a. staccato, b. libretto, c. largo, d. diminuendo) :: FORTISSIMO : PIANISSIMO

41. STOCKHOLDER : (a. exchange, b. owner, c. proxy, d. repertory) :: STAR : UNDERSTUDY

It is hoped that the operational MAT was free of such items. Otherwise, it might be supposed that such items would disadvantage nonnative speakers of English who were not aware of cultural facts as opposed to being ignorant of vocabulary items.

The results of this study indicate that the MAT, by extension from the PMAT, may be culturally laden, testing analogies based on a western humanistic education. There were, indeed, a few subjects who had received an education based on an eastern orientation and who were currently successful graduate students at the university, but who nevertheless performed poorly on the PMAT (for example, Navajo speakers and a Hindi speaker for whom even a Ph.D. from an Indian institution did not make up for this different cultural background). In addition to measuring analogy-solving abilities, then, the MAT appears to measure knowledge of western culture to some degree and to assume an education in the humanities.

These considerations may invalidate the MAT for testing nonnative speakers of English and invoke the need for alternative methods of evaluation to gain more insight into the students' authentic competence. Tests based on high school curriculum and skills (e.g., Scholastic Achievement Test) or graduate school achievement (e.g., Graduate Record Examination) may also reflect western, humanistic education and thus may not be any more appropriate for nonnative speakers of English than the MAT. Until such time as existing tests may be validated or new tests developed and validated for use with nonnative speakers of English and with nonspeakers of English, alternative methods of evaluation should be used. It is strongly recommended that writing samples, resumes, letters of interest, interviews, letters of recommendation, past scholastic files and grades, and portfolio assessment be included in these alternative measures. A holistic approach in assessment is needed.

Classroom Teaching

Time limits are specified in speed tests when class exercises, quizzes, or tests are to be completed in a restricted time period. In such cases, slower students may not be able to complete the task. Students whose learning mode is RO (reflective observation) may thus be disadvantaged.

Since the RO learning mode correlated with lower PMAT results, teachers may do well to identify such students early in the course and give them special attention. In order to redress the inequality and to diminish the stress factor for slower students, it may be desirable to use power tests, in which adequate time is given for the average student to complete a given task, rather than speed tests. It is recommended that a power test be given rather than a speed test for decision-making purposes.

It is also recommended that both the form and the content of analogies be included in the curriculum. Examples of such content include musical terminology, Greek mythology, and a survey of literary figures, both authors and protagonists, as well as many other areas.

The results of this study do not readily yield suggestions such as which language or combinations of languages would be worthwhile to teach people and at what ages so that they will later succeed better in academic endeavors. Other more complex measures of cognitive abilities and language proficiency, however, might yield more generalizable findings.

Recommendations for Further Research

The findings, discussion and conclusions, and educational implications that have been presented, warrant the following recommendations for further research.

Socioeconomic Factors and Language Proficiency

Although efforts have been made to avoid bias in this study, it has not been totally prevented. Since only one assessment criterion of language proficiency, a self-report questionnaire, was used in this study, a future study might include additional measures of proficiency such as teachers' ratings and standardized language proficiency tests. Furthermore, more items might be included on socioeconomic background such as parents' education and knowledge of foreign languages, yearly per-capita income in the family, and the number of people per room living at home.

It is important to control for Socioeconomic status (SES). Bilinguals from lower SES groups may not show the same cognitive advantages as higher SES groups. This factor may have even skewed results of studies showing that bilingualism has a negative effect on intelligence. Since many Americans who speak more than one language are immigrants, the samples used in these studies were probably taken from low-income families. The reason would lie in other social, psychological, and educational factors and may not be connected to bilingualism. Lack of SES control may have resulted in early studies in bilingualism, those before Peal and Lambert's famous 1962 study, showing bilingualism to have a detrimental effect on the person.

In future studies similar to that of Jacobs and Pierce (1965), a cultural, socioeconomic variable might be added to the research study yielding more widely applicable results.

It is recommended that studies be conducted investigating language proficiency at various points on the continuum from monolingualism through partial multilingualism to competent multilingualism controlling for both degree of language proficiency and SES. Subjects in the various language proficiency groups could also be matched according to SES criteria.

Language Groups

Similar studies should be conducted with larger groups of languages being represented. It may be that persons who are multilingual within a language group (e.g., Romance languages: French and Spanish) may have less difficulty with standardized tests such as the MAT, whereas persons who are bilingual between two distinct language groups (e.g., Romance and Semitic: French and Arabic) may have developed different thinking patterns and therefore experience more difficulties. It is recommended that further studies also include monolinguals and multilinguals from other language groups in an effort to make the results more generalizable.

In order to gain further insight into the cognitive strategies of multilinguals, it would be helpful to conduct in-depth research interviews with multilingual subjects from various language groups while they are solving analogies. It would be possible then to discuss the reasons for their answers and to delve into their thought processes while they are solving the analogies. Thinking-aloud protocols, meta-cognitive processes, could be used as the primary data base for analogy research in addition to the written MAT. This would provide qualitative information on the thinking strategies in addition to quantitative information. This would supply more information on the use of different languages in analogy solving, and on the thinking processes of persons in various language groups while they are involved in the solution of the analogies. In such a study, it is recommended that a comparison between monolinguals and multilinguals be made in addition to comparisons between various language groups in order to add depth to the research design.

Language Groups, Learning Styles, and Analogy-Solving Ability

Investigations of preferred learning styles of specific language groups could be conducted. Identifying the learning style preferences of different language groups (e.g., Romance, Germanic, Indian, Semitic, Asian, Hindi) may have wide-ranging implications for curriculum planning and implementation. It is recommended that research be carried out to identify the reasons why some subjects (for example Hindi speakers and Navajo speakers) did not perform well on the PMAT.

Language, Culture, and Intelligence

The issue of language and intelligence is extremely complex. Many researchers have discussed the possibility that language and culture affect cognition (Cummins, 1979, 1981; Glick, 1975; Langacker, 1976; Sternberg, 1988; Tel, 1984; Whorf, 1940/1956; Witkin, 1976). Language and culture are involved in semantic representation, and these may affect cognitive flexibility. There are researchers who link multilingualism and cognitive flexibility (Albert and Obler, 1978; Anisfeld, 1964; Edelsky et al., 1983; Fradd, 1982; Gowan and Torrance, 1965; Noonan, 1980; Oren, 1981; Powers and Lopez, 1985; Segalowitz, 1977; Vygotsky, 1939/1962).

Knowing different languages may enhance analogy-solving ability. According to Piaget (1974), one learns and develops cognitively through disequilibrium. In linguistic terms, the bilingual is constantly making cognitive decisions as to which semantic field is covered by a word in each language. Since different languages divide up reality in different ways (Whorf 1940/1956), the bilingual individual continually chooses which semantic features are decisive in each context, which set of semantic features to bring to bear in any specific discourse context. Constant "language-hopping" exercises trains people for the higher flexibility needed in solving analogies. It is recommended that studies be conducted on the advantages of contrastive linguistics in second-language teaching and the ability to solve analogies.

Learning Styles and Cognitive Skills

Most important, however, would be an elucidation of problem-solving skills. This is an area where various research studies categorize, define, and describe cognitive skills differently, using different measurement instruments and statistical procedures. Indeed, different versions of the same learning style inventory measure different skills (Dunn et al., 1981, 1985; Schmeck, 1981, 1988; Schmeck et al., 1977). Precise and uniform definitions are needed for terms such as cognitive processes, thinking skills, culture, bias, achievement, intelligence, and performance. To arrive at such uniformity, it is recommended that parallel studies be conducted using different instruments for examining cognition or cognitive skills.

Test Instruments

There may be types of items on the PMAT (or MAT) on which multilinguals consistently do better or worse than monolinguals. It is recommended that an item analysis, taking into account the subjects' first and second languages, be carried out. Such an analysis might reveal items that are missed by many nonnative speakers of English who have done well on other types of tests.

The findings in the present study might have been more sharply defined using the actual MAT rather than the practice test. Assuming that the PMAT is similar to the MAT but not identical (e.g., some items may be easier or more difficult), results may not reflect findingsthat would have been obtained using the MAT. It is recommended that future research use the actual MAT.

It is also recommended that further research be conducted using other forms of measurement of cognitive abilities in the various bilingual groups and language groups.

As an alternative to self-report questionnaires, it is recommended that future research use cloze and other pragmatic tests to determine language proficiency and degree of bilingualism.

The issue of ethnicity affecting MAT results has been addressed by Graham (1991) who found a strong relationship between ethnic background and graduate school grade point average (GPA) when using the MAT. His study, however, did not specify the language and ethnic groups studied. Further research linking MAT (and even GMAT) scores and various ethnic and language groups would be useful.

Indeed, further research could delve into the broad question of culture bias in tests predicting academic success on all levels. This is especially important as more bilinguals and multilinguals apply to institutes of higher learning in the United States. It is recommended that research be conducted on the correlations between results on the various selection examinations and different language and ethnic groups.

Other Cognitive Skills

To support and clarify the issues raised here, there is a need for similar studies and for further research to be conducted on the relationship among multilingualism, learning styles, and specific areas of cognition. Further research would attempt to illuminate the area of categorizing language-related cognitive skills. However, subsequent studies might supply more information if the data were gathered individually and orally instead of by means of a written pen-and-paper test.

Language Modality and Cognitive Skills

It is recommended that investigations of gender differences and preferred learning styles in multilinguals be conducted. For example, analysis by gender might have found different learning modes and/or styles for different levels of multilingualism. Kolb (1971) found significantly more females than males to have concrete learning styles. Teaching modes, then, could be tailored to match learning styles.

It is recommended that research be conducted investigating whether oral proficiency or literacy (reading and writing) proficiency in additional languages are important factors that enhance cognitive abilities. This is connected to the questions of age and setting when additional languages are acquired, and the purposes for which each language is used. This question is also linked to the influence of culture, since at an early age, the home, more than the school, is the locus of cultural influences as a setting for language acquisition.

A Final Note

This study underscores the need for further descriptive and qualitative studies, in addition to quantitative studies, to identify specific cognitive processes of the multilingual when solving analogies. Only with the guidance of such studies is it likely that multilingualism will no longer be seen as a hindrance to learning but a source of cognitive flexibility, and that the full importance and effects of multilingualism and the multilinguals' cognitive strategies will be appreciated. Whether or not it assists in attaining high scores on psychometric examinations, however, multilingualism enriches the individual in numerous aspects of life.

APPENDIX A

SELF-REPORT LANGUAGE SURVEY QUESTIONNAIRE

LANGUAGE SURVEY QUESTIONNAIRE

1) What is your name? (You may write any imaginary name)

____

2) How old are you?

____

3) What is your occupation or profession?

____

4) How many years did you attend high school?

____

How many years did you attend college?

____

What is the highest degree or certificate you attained?

____

5) What is the first language(s) you learned?

____

6) What language(s) did your mother or stepmother speak to you?

____

7) What language(s) did your father or stepfather speak to you?

____

8) What language(s) did your grandparents or stepgrandparents speak to you?

____

9) What other language(s) were spoken to you as a child? By whom?

____

What languages are spoken to you today? By whom?

10) In what languages are you able to hold a conversation today?

11) In what language(s) are you able to read a newspaper?

In what language(s) are you able to read a book "for fun"?

In what language(s) are you able to read a book for studies? A technical book? A professional book?

12) What languages did you learn at school and at what age did you learn these languages?

13) What languages do you feel you know superficially?

14) What languages do you feel you know well?

15) In what languages can you write a letter to a friend?

16) What languages do you use in your home? With whom?

17) List all the languages you use, with whom you use these languages and for what purposes.

language	with whom	when (and/or why)

18) What language(s) do you consider you know best?

____

19) What language(s) do you think you know second best?

____

20) List other languages you know at all and rank them from 3rd, 4th, and so on.

____

____

21) Are there any languages you only understand when you hear, but do not speak or read? What are they?

____

22) What language or languages do you use at work or school?

____

23) Which language(s) would you prefer to use when doing the following activities:

a) going to the movies__________________

b) listening to the radio_______________

c) singing_______________________________

d) watching television________________

e) talking to a friend________________

f) getting a letter from a friend______

g) having an argument_________________

h) studying something new______________

i) learning how to drive_______________

j) speaking to your parents____________

k) speaking to your children___________

l) speaking to your spouse (or boyfriend or girlfriend)____________________________

m) shopping for groceries______________

n) counting____________________________

24) What language do you use when you:

a) pray?_______________________________

b) hit your thumb with a hammer?_______

25) When you learned your second language, did you continue speaking and using your first language?

a) often b) sometimes c) never

26) When you speak English, do you think in English? If not, in what language do you think?

____

When you speak in your second language, do you think in that language? If not, in what language do you think?

____

27) Have you ever taken the Miller Analogies Test?

____

If yes, when (year)?____________________

APPENDIX B

LEARNING STYLE INVENTORY

Learning Style Inventory

Instructions

There are nine sets of four words listed below. Rank the words in each set, by assigning a "4" to the word that best characterizes your learning style, a "3" to the word that next best characterizes your learning style, a "2" to the next most characteristic word, and a "1" to the word that is least characteristic of you as a learner.

You may find it hard to rank these words. But keep in mind that there are no right or wrong answers—all the choices are equally acceptable. The aim of the inventory is to describe your *style* of learning, not to evaluate your learning ability.

Be sure to assign a *different* rank number to each of the four words in each set; *do not make ties.*

1.	___ discriminating	___ tentative	___ involved	___ practical
2.	___ receptive	___ relevant	___ analytical	___ impartial
3.	___ feeling	___ watching	___ thinking	___ doing
4.	___ accepting	___ risk-taker	___ evaluative	___ aware
5.	___ intuitive	___ productive	___ logical	___ questioning
6.	___ abstract	___ observing	___ concrete	___ active
7.	___ present-oriented	___ reflecting	___ future-oriented	___ pragmatic
8.	___ experience	___ observation	___ conceptualization	___ experimentation
9.	___ intense	___ reserved	___ rational	___ responsible

Scoring

The four columns of words above correspond to the four learning-style scales: CE, RO, AC, and AE. To compute your scale scores, write your rank numbers in the boxes below for the designated items. For example, for your AC score, fill in the rank numbers you have assigned to items 2, 3, 4, 5, 8, and 9 in the third column above (i.e., for "analytical," "thinking," etc.). Compute your scale scores by totaling the rank numbers in each set of boxes below.

Score items:	**Score items:**	**Score items:**	**Score items:**
2 3 4 5 7 8	1 3 6 7 8 9	2 3 4 5 8 9	1 3 6 7 8 9
☐☐☐☐☐☐	☐☐☐☐☐☐	☐☐☐☐☐☐	☐☐☐☐☐☐
CE = ________	**RO =** ________	**AC =** ________	**AE =** ________

To compute the two combination scores, subtract CE from AC and subtract RO from AE. Preserve negative signs if they appear.

AC CE
AC—CE: ☐ – ☐ = ______

AE RO
AE—RO: ☐ – ☐ = ______

APPENDIX C

PRACTICE MILLER ANALOGIES TEST

100 PRACTICE ITEMS FOR THE MAT

1. (*a.* brown, *b.* pink, *c.* orange, *d.* yellow) : Red :: Green : Blue
2. Cinnamon : (*a.* root, *b.* bark, *c.* leaf, *d.* fruit) :: Sugar : Sap
3. Seek : Find :: (*a.* locate, *b.* book, *c.* retrieve, *d.* listen) : Hear
4. Bonaparte : Jackson :: Little : (*a.* old, *b.* young, *c.* large, *d.* few)
5. A.W.O.L. : Soldier :: (*a.* expelled, *b.* tardy, *c.* truant, *d.* suspended) : Student
6. Salt : Hypertension :: Sugar : (*a.* cholesterol, *b.* carbohydrates, *c.* hyperthyroidism, *d.* diabetes)
7. Celsius : (*a.* troy, *b.* centigrade, *c.* Richter, *d.* Fahrenheit) :: Temperature : Tremor
8. (*a.* tepid, *b.* arid, *c.* fetid, *d.* vapid) : Humid :: Desert : Swamp
9. Refinery : (*a.* waste, *b.* power, *c.* gasoline, *d.* liquor) :: Distillery : Alcohol
10. (*a.* chop, *b.* lamb, *c.* calf, *d.* cow) : Sheep :: Veal : Cow
11. $2^3 : 2^2$ :: (*a.* 2, *b.* 4, *c.* 6, *d.* 8) : 1

Mark Your Answers Here

	a	b	c	d
1.	☐	☐	☐	☐
2.	☐	☐	☐	☐
3.	☐	☐	☐	☐
4.	☐	☐	☐	☐
5.	☐	☐	☐	☐
6.	☐	☐	☐	☐
7.	☐	☐	☐	☐
8.	☐	☐	☐	☐
9.	☐	☐	☐	☐
10.	☐	☐	☐	☐
11.	☐	☐	☐	☐

12. (*a.* e.g., *b.* i.e., *c.* N.B., *d.* cf.) : Etc. :: That is : And so forth
13. V : (*a.* L, *b.* C, *c.* M, *d.* D) :: I : X
14. (*a.* cure, *b.* epidemic, *c.* immunity, *d.* patient) : Shade :: Inoculation : Parasol
15. 97° : 45° :: (*a.* angle, *b.* equilateral, *c.* obtuse, *d.* cosine) : Acute
16. Auricle : Ventricle :: Ventricle : (*a.* jugular, *b.* carotid, *c.* coronary, *d.* aorta)
17. (*a.* casino, *b.* caucus, *c.* circus, *d.* concert) : Croupier :: Bank : Teller
18. Magna Charta : Constitution :: Runnymede : (*a.* Boston, *b.* Philadelphia, *c.* Washington, *d.* New York)
19. Induction : (*a.* confirmation, *b.* graduation, *c.* ordination, *d.* resistance) :: Soldier : Priest
20. (*a.* biennial, *b.* bulbous, *c.* deciduous, *d.* perennial) : Annual :: Tulip : Zinnia
21. Desideratum : Desiderata :: Man : (*a.* woman, *b.* principle, *c.* men, *d.* participle)
22. Warp : Wood :: Blister : (*a.* metal, *b.* paint, *c.* rattan, *d.* tile)
23. Californium : Radium :: (*a.* common, *b.* artificial, *c.* radioactive, *d.* element) : Natural
24. Candide : Voltaire :: (*a.* Pirandello, *b.* Cid, *c.* Quixote, *d.* Lazarillo) : Cervantes
25. Rodin : Monet :: (*a.* composer, *b.* writer, *c.* philosopher, *d.* sculptor) : Painter
26. (*a.* frame, *b.* door, *c.* sash, *d.* sill) : Window :: Panel : Pane
27. Bronze : Copper :: Pewter : (*a.* iron, *b.* steel, *c.* tin, *d.* brass)

Mark Your Answers Here

	a	b	c	d
12.	☐	☐	☐	☐
13.	☐	☐	☐	☐
14.	☐	☐	☐	☐
15.	☐	☐	☐	☐
16.	☐	☐	☐	☐
17.	☐	☐	☐	☐
18.	☐	☐	☐	☐
19.	☐	☐	☐	☐
20.	☐	☐	☐	☐
21.	☐	☐	☐	☐
22.	☐	☐	☐	☐
23.	☐	☐	☐	☐
24.	☐	☐	☐	☐
25.	☐	☐	☐	☐
26.	☐	☐	☐	☐
27.	☐	☐	☐	☐

28. (*a.* loop, *b.* cowl, *c.* rope, *d.* stretch) : Coil :: Ring : Spring

29. Horse : (*a.* squid, *b.* shark, *c.* dolphin, *d.* octopus) :: Camel : Walrus

30. (*a.* 5, *b.* 20, *c.* 50, *d.* 100) : 10 :: Lincoln : Hamilton

31. Gutenberg : (*a.* television, *b.* theology, *c.* genetics, *d.* printing) :: Marconi : Radio

32. Computer : Chronometer :: Abacus : (*a.* sundial, *b.* ruler, *c.* calculator, *d.* scale)

33. Graphology : (*a.* personality, *b.* printing, *c.* code, *d.* handwriting) : Phrenology : Skull

34. (*a.* lion, *b.* unicorn, *c.* serpent, *d.* eagle) : Minotaur :: Phoenix : Griffin

35. Murder : (*a.* arson, *b.* rape, *c.* slander, *d.* burglary) :: Felony : Misdemeanor

36. (*a.* segment, *b.* sector, *c.* perpendicular, *d.* radius) : Line :: Arc : Circle

37. Presto : (*a.* staccato, *b.* libretto, *c.* largo, *d.* diminuendo) :: Fortissimo : Pianissimo

38. Burnoose : Cassock :: Arab : (*a.* caftan, *b.* priest, *c.* hummock, *d.* shepherd)

39. (*a.* wall, *b.* ceiling, *c.* basement, *d.* roof) : Floor :: Plumb : Level

40. Fear : Phobia :: Urge : (*a.* yearning, *b.* drive, *c.* compulsion, *d.* necessity)

41. Stockholder : (*a.* exchange, *b.* owner, *c.* proxy, *d.* repertory) :: Star : Understudy

42. Taster : Wine :: (*a.* writer, *b.* critic, *c.* performer, *d.* director) : Film

Mark Your Answers Here

	a	b	c	d
28.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
29.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
30.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
31.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
32.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
33.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
34.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
35.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
36.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
37.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
38.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
39.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
40.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
41.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
42.	⁞⁞	⁞⁞	⁞⁞	⁞⁞

43. (*a.* Brahman, *b.* Shaman, *c.* Hanuman, *d.* Jain) : Sudra :: Nobility : Serfdom

44. Skyscraper : Girder :: Pier : (*a.* dock, *b.* anchor, *c.* plank, *d.* pile)

45. Dive : (*a.* breast, *b.* float, *c.* stroke, *d.* sink) :: Swan : Butterfly

46. Mollusk : (*a.* fish, *b.* cell, *c.* plant, *d.* mammal) :: Pearl : Ambergris

47. Eire : Ireland :: Mohammedanism : (*a.* Egypt, *b.* Protestantism, *c.* Mecca, *d.* Islam)

48. (*a.* axiology, *b.* epistemology, *c.* teleology, *d.* eschatology) : Ontology :: Knowledge : Being

49. Gauge : Shotgun :: (*a.* bullet, *b.* caliber, *c.* barrel, *d.* rod) : Pistol

50. Plank . (*a.* saw, *b.* hammer, *c.* pirate, *d.* board) :: Loaf : Slice

51. (*a.* onionskin, *b.* seal, *c.* security, *d.* tie) : Bond :: Translucent : Opaque

52. Pavlov : Dogs :: Harlow : (*a.* cats, *b.* monkeys, *c.* rats, *d.* humans)

53. Gold : (*a.* brass, *b.* silver, *c.* lead, *d.* dross) :: Wheat : Chaff

54. Alexander : Macedonia :: Hannibal : (*a.* Rome, *b.* Greece, *c.* Egypt, *d.* Carthage)

55. Sinanthropus : Pithecanthropus :: (*a.* Peking, *b.* Hong Kong, *c.* Cairo, *d.* Kabul) : Java

56. Elbow : Fulcrum :: Biceps : (*a.* lever, *b.* balance, *c.* weight, *d.* force)

57. Whey : Curds :: (*a.* cheese, *b.* water, *c.* bread, *d.* buttermilk) : Butter

Mark Your Answers Here

	a	b	c	d
43.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
44.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
45.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
46.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
47.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
48.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
49.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
50.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
51.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
52.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
53.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
54.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
55.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
56.	⁞⁞	⁞⁞	⁞⁞	⁞⁞
57.	⁞⁞	⁞⁞	⁞⁞	⁞⁞

58. (*a*. interest, *b*. bond, *c*. principal, *d*. certificate) : MUNICIPALITY :: LOAN : INDIVIDUAL

59. COMMON : (*a*. stock, *b*. plain, *c*. combined, *d*. crossing) :: INTERSECTION : UNION

60. HOMOPHONE : (*a*. paradigm, *b*. antonym, *c*. synonym, *d*. acronym) :: SOUND : MEANING

61. VINEGAR : (*a*. apple, *b*. oil, *c*. lemon, *d*. tea) :: ACETIC : CITRIC

62. (*a*. Rembrandt, *b*. Dali, *c*. Renoir, *d*. Klee) : CEZANNE :: MANET : MONET

63. MASONS : (*a*. jars, *b*. trowels, *c*. bricks, *d*. separators) :: DRAFTSMEN : DIVIDERS

4. TABLE : BILL :: (*a*. shelf, *b*. shelve, *c*. conveyor, *d*. convey) : MOTION

5. BISMARCK : GERMANY :: (*a*. Columbus, *b*. Franco, *c*. Vivaldi, *d*. Garibaldi) : ITALY

6. -IVE : -ION :: ADJECTIVE : (*a*. verb, *b*. conjunction, *c*. noun, *d*. adverb)

7. DRAY : LIMOUSINE :: (*a*. passenger, *b*. engineer, *c*. cyclist, *d*. teamster) : CHAUFFEUR

8. VASE : AMPHORA :: FLOWERS : (*a*. wine, *b*. Greek, *c*. leaves, *d*. grain)

9. (*a*. giraffe, *b*. platypus, *c*. opossum, *d*. raccoon) : CAMEL :: MARSUPIAL : RUMINANT

0. SALT : (*a*. sugar, *b*. chlorine, *c*. hydrogen, *d*. saline) :: WATER : OXYGEN

1. (*a*. braid, *b*. insignia, *c*. epaulet, *d*. chevron) : SERGEANT :: STAR : GENERAL

2. PUPIL : (*a*. iris, *b*. fovea, *c*. lens, *d*. retina) :: APERTURE : DIAPHRAGM

Mark Your Answers Here

	a	b	c	d
58.	⁞	⁞	⁞	⁞
59.	⁞	⁞	⁞	⁞
60.	⁞	⁞	⁞	⁞
61.	⁞	⁞	⁞	⁞
62.	⁞	⁞	⁞	⁞
63.	⁞	⁞	⁞	⁞
64.	⁞	⁞	⁞	⁞
65.	⁞	⁞	⁞	⁞
66.	⁞	⁞	⁞	⁞
67.	⁞	⁞	⁞	⁞
68.	⁞	⁞	⁞	⁞
69.	⁞	⁞	⁞	⁞
70.	⁞	⁞	⁞	⁞
71.	⁞	⁞	⁞	⁞
72.	⁞	⁞	⁞	⁞

73. (*a*. keys, *b*. pedals, *c*. wires, *d*. stops) : BELLS :: PIANO : CARILLON

74. SPUN : SPINNING :: PARTICIPLE : (*a*. predicate, *b*. tense, *c*. present, *d*. gerund)

75. SOUP : TUREEN :: WINE : (*a*. cask, *b*. snifter, *c*. flagon, *d*. glass)

76. MASTICATE : MEDITATE :: (*a*. arm, *b*. larynx, *c*. nerves, *d*. teeth) : BRAIN

77. PRADO : (*a*. Madrid, *b*. Lisbon, *c*. Florence, *d*. Mexico City) :: LOUVRE : PARIS

78. PRISM : (*a*. water, *b*. spectrum, *c*. light, *d*. sound) :: CENTRIFUGE : MIXTURE

79. 10 mm. : 1 cm. :: 1^{10} : (*a*. 1, *b*. 10, *c*. 100, *d*. 1000)

80. (*a*. architect, *b*. vandal, *c*. curator, *d*. thief) : PROPERTY :: ICONOCLAST : IMAGES

81. LIGHT : PHOTO- :: (*a*. enlargement, *b*. sound, *c*. sight, *d*. distance) : TELE-

82. PUCCINI : (*a*. Vivaldi, *b*. Verdi, *c*. Mozart, *d*. Bach) :: BUTTERFLY : FIGARO

83. SALK : POLIO :: (*a*. Jenner, *b*. Sabin, *c*. Lister, *d*. Pasteur) : SMALLPOX

84. (*a*. festival, *b*. week, *c*. moon, *d*. Mercury) : MONDAY :: HOLY : HOLIDAY

85. * : ASTERISK :: (*a*. @, *b*. &, *c*. #, *d*. ∧) : AMPERSAND

86. CENOZOIC : ERA :: PLEISTOCENE : (*a*. epoch, *b*. year, *c*. period, *d*. century)

87. OVERTURE : (*a*. symphony, *b*. prelude, *c*. minuet, *d*. concertos) :: 1812 : BRANDENBURG

Mark Your Answers Here

	a	b	c	d
73.	⁞	⁞	⁞	⁞
74.	⁞	⁞	⁞	⁞
75.	⁞	⁞	⁞	⁞
76.	⁞	⁞	⁞	⁞
77.	⁞	⁞	⁞	⁞
78.	⁞	⁞	⁞	⁞
79.	⁞	⁞	⁞	⁞
80.	⁞	⁞	⁞	⁞
81.	⁞	⁞	⁞	⁞
82.	⁞	⁞	⁞	⁞
83.	⁞	⁞	⁞	⁞
84.	⁞	⁞	⁞	⁞
85.	⁞	⁞	⁞	⁞
86.	⁞	⁞	⁞	⁞
87.	⁞	⁞	⁞	⁞

88. FRENCH : ROMAN :: RUSSIAN : (*a.* Cyrillic, *b.* Greek, *c.* Cuneiform, *d.* Arabic)

89. MUSE : SANDMAN :: (*a.* victory, *b.* fortune, *c.* reflection, *d.* inspiration) : SLEEP

90. (*a.* Chamberlain, *b.* Luther, *c.* Gandhi, *d.* Calvin) : WILSON :: 95 : 14

91. HELOISE : (*a.* Tristan, *b.* Benedict, *c.* Abelard, *d.* Hector) :: BEATRICE : DANTE

92. LINES : POINT :: PLANES : (*a.* circle, *b.* surface, *c.* intersection, *d.* line)

93. HYPOTHETICAL : (*a.* evidence, *b.* supposition, *c.* fact, *d.* controversy) :: EMPIRICAL : EXPERIENCE

94. (*a.* Greece, *b.* crowds, *c.* noise, *d.* foreigners) : XENOPHOBIA :: HEIGHT : ACROPHOBIA

95. PTOLEMAIC : ASTRONOMY :: (*a.* Galilean, *b.* Lamarckian, *c.* Mendelian, *d.* Newtonian) : EVOLUTION

96. HEN : DOE :: CHICKEN : (*a.* fox, *b.* turkey, *c.* rabbit, *d.* raccoon)

97. BOWL : (*a.* tine, *b.* knife, *c.* ball, *d.* tong) :: SPOON : FORK

98. O'HIGGINS : BOLIVAR :: (*a.* Peru, *b.* Chile, *c.* Guatemala, *d.* Brazil) : VENEZUELA

99. (*a.* pride, *b.* shift, *c.* hold, *d.* spy) : CLUTCH :: ROAR : PEEP

100. NAPOLEON : WAGON :: (*a.* coin, *b.* baker, *c.* general, *d.* statue) : WAINWRIGHT

Mark Your Answers Here

	a	b	c	d
88.	☐	☐	☐	☐
89.	☐	☐	☐	☐
90.	☐	☐	☐	☐
	a	b	c	d
91.	☐	☐	☐	☐
92.	☐	☐	☐	☐
93.	☐	☐	☐	☐
94.	☐	☐	☐	☐
95.	☐	☐	☐	☐
	a	b	c	d
96.	☐	☐	☐	☐
97.	☐	☐	☐	☐
98.	☐	☐	☐	☐
99.	☐	☐	☐	☐
100.	☐	☐	☐	☐

APPENDIX D

PARTICIPANT CONSENT FORM

PARTICIPANT CONSENT FORM

Eleanor Avinor, a graduate student in the Department of Curriculum and Instruction in Multicultural Teacher Education at the College of Education of the University of New Mexico, will be conducting research during the 1988 Spring term. Her project will deal with the relationships of lingualism, learning style, and cognition. Monolinguals, bilinguals, and multilinguals have been selected for data collection.

If you agree to participate in this research study, you will be requested to answer three questionnaires on the following topics: 1) the languages you know, when you learned them, how well you know different languages; 2) the way you learn; and 3) a sample test of 100 analogies. The questionnaires are to be completed in approximately one hour and a quarter to one hour and a half. Participation is strictly voluntary.

The researcher foresees no risks or discomfort for the participants.

If you have any questions or comments, or would like further information, please call or write Eleanor Avinor at 823-9149, 6401 Academy NE #25, Albuquerque NM 87109 or Room 215, Marron Hall, UNM. Also for additional inquiries or problems, contact Dr. Peggy Blackwell, Assistant Dean, 277-3638, and for legal questions contact the Office of Risk Management, Lamy Building, Santa Fe NM 87503.

I have received two copies of this form, one to return and one to keep. I have read this consent form and I agree to participate.

NAME:

DATE:

APPENDIX E

MEMBERS OF THE JURY

MEMBERS OF THE JURY

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APPENDIX F

COMMITTEE TO CLASSIFY SUBJECTS

COMMITTEE TO CLASSIFY SUBJECTS INTO MONOLINGUALS/PARTIAL MULTILINGUALS AND COMPETENT MULTILINGUALS

Janet Bronitsky
Administrator of Congregation Albert
Albuquerque, New Mexico 87110

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